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One Billion Yuan Earmarked for 38 Energy Projects

40100078A Beijing CHINA DAILY (Economics and Business) in English 18 Sep 90 p 2

[Article by staff reporter Huang Xiang: "Energy Industry Plans 38 Projects"]

[Text] China yesterday announced a massive plan to construct 38 energy projects to fire up the country's coal and electricity industry in the latter half of 1990.

The programme involves investment of around 1 billion yuan ($212 million) and sources told CHINA DAILY yesterday that these projects, which include 37 coal mines and one coal-electricity complex, may soon have funds available for preparatory work.

The total annual capacity of the projects will reach 53.9 million tons of coal and 1 million kilowatts of electricity, according to an official with the State Energy Investment Corporation.

The corporation, the energy industry's leading financial arm, is responsible for the construction of large and medium-sized coal and electricity undertakings.

Of the total investment, 95 percent will come from the State Treasury, which usually spends around 20 billion yuan ($4.25 billion) on energy projects every year.

The rest comes from local sources, and will largely be spent on the coal-electricity complex in Inner Mongolia Autonomous Region in North China.

According to the official, no overseas funds are involved since most foreign firms are reluctant to invest in China's coal projects as the current low price has dimmed any prospects of profit.

He said about 300 million yuan ($63.8 million) will be spent this year on such preparatory work as the purchase of land and construction of accommodation and communications facilities.

He said that of the 38 projects, 14 had actually begun preparatory work before 1990 and had thus been included on the list.

Altogether there are 18 projects, each with an annual capacity of more than 1 million tons of coal; a handful of them are able to produce more than 4 million tons of coal a year.

Most of these major projects are in the coal-abundant regions of Shanxi, Shaanxi, Shandong, Anhui and Henan provinces and in Northeast China.

The most impressive scheme is the first-phase of Yiminhe Coal-Electricity Project in Inner Mongolia, a key State-designated demonstration project for the industry.

It involves a 4-million-ton open pit and two 500,000-kilowatt generating units.

"Coal from the open pit will be sent to power plants nearby for electricity generation instead of being transported to faraway plants," said an official of the Ministry of Energy Resources.

With a total investment of three billion yuan ($637 million), it is expected to greatly ease power shortages in the region and in the heavily-industrialized Northeast China.

Development of Amorphous Silicon Solar Cells With Efficiency Over 10 Percent

906B0110A Beijing TAIYANGNENG XUEBAO [ACTA ENERGIAE SOLARIS SINICA] in Chinese Vol 11 No 3, Jul 90 pp 230-237

[Article by Hu Hongxun [5170 1347 8113] of Tianjin Institute of Power Sources (presently employed by Tianjin Kangshou Energy Corporation): "Development of Amorphous Silicon Solar Cells With Efficiency Over 10 Percent"]

[Text] **Abstract**

This paper reports the research and development results of amorphous ITO/SiO_2/na-SiC:H/ia-Si:H/pμ_CSi:H/Mo silicon solar cells. It analyzes the interface junction barrier and recombination effect between the transparent conductive oxide (TCO) film and n or p type amorphous silicon film. The paper emphasizes that to overcome this interfacial recombination effect is an important means to improve cell performance, especially FF and I_{SC} of n-i-p/Mo cell on metal substrate. This paper also analyzes the effect of TCO thermal electron on saturation current of the solar cell. It reports the deposition of a SiO_2 passivation layer on top of na-SiC:H by electron beam evaporation in order to lower the saturation current of the cell. I_o of cells with the SiO_2 passivation layer is two orders of magnitude lower than that without it. The short wavelength response of the cell is significantly improved due to reduction in interfacial recombination. The maximum efficiency is 10.42 percent and FF is 65.8 percent, representing an improvement of 15.5 percent and 8.33 percent, respectively. These results demonstrate that we have made new progress in the development of amorphous silicon solar cells.

Introduction

In the past decade, due to significant progress in the research, development and production, amorphous silicon solar cells have become extremely competitive against crystalline silicon solar cells. This is attributed to the development of physics on amorphous materials and continuous innovations in cell structure and technique.

We also made major progress in the development of amorphous silicon solar cells. In 1982, the Pd/iaSi:H/naSi:H Schottky barrier cell was fabricated and its efficiency is 3-4 percent. In 1983, a simple n-i-p cell was made using new deposition equipment and a special electrode structure and its efficiency is 6.42 percent. In 1984, the structure of the device was further improved to raise the effective dopant concentrations in the n and p layers and to improve the electrical conductivity and light transmittance of the ITO film. Furthermore, the cell was annealed and its efficiency reached 7.85 percent. In 1985, naSiC:H film was used as the top cell layer and pμ_CSi:H was used as the bottom layer to substantially increase the FF and I_{SC} of the cell. The efficiency of the cell reached 8.55 percent, approaching the 1982 level in the world. This was a major breakthrough for China because only cells with over 8 percent efficiency are economically viable.[1] In 1986, research on boron doping of the i layer began and the cell efficiency was raised to 9.02 percent. From the standpoint of technology research, China has caught up with the rest of the world. As for how to further improve cell efficiency in China, especially to solve the large gap in FF, we have analyzed several problems as follows.

I. Surface Recombination Rate and Interfacial Recombination of Amorphous Silicon

During the initial development stage of single crystal silicon cell, surface recombination was not taken into consideration because surface recombination rate of single crystal silicon is usually below 10^4 $cm^2/s \times V$. However, as we approached 20 percent efficiency, surface recombination became an important issue.[2] Surface recombination is very serious in amorphous silicon. It is primarily due to the following two reasons. Uneven distribution of hydrogen, especially higher hydrogen content on the surface, causes dangling bonds on the surface uncompensated. The high surface state density is the most important cause for surface recombination. Based on reference 3, surface recombination rate for amorphous silicon film is 5×10^{12} - 2×10^{13} $cm^{2)}$ junction interface, due to contamination by residual gas in the deposition chamber, the problem is even more complex.

The TCO layer at the top of the cell is mainly indium tin oxide (ITO) and tin oxide. They are heavily doped degenerate semiconductors which can form a junction barrier with either naSi:H or paSi:H in a cell. Thus, it creates a space charge region at the top of a normal n-i-p or p-i-n cell as shown in Figure 1. The energy band of a normal p-i-n cell is shown in thick solid lines. The bending (thin dotted lines) is due to barrier E_o created by TCO. In this barrier region, because of the extremely short life of electrons and holes in the p and TCO region (mainly in the p region) and the tremendously high recombination rate,[4] absorption of light becomes useless. Our calculation shows that light at 3650 Angstroms is completely absorbed after passing through a 100 Angstroms thick thin film. Therefore, this kind of interfacial recombination could spoil the short wavelength response of the cell. If the energy band contraction effect in the p region is also taken into account, recombination would be even more severe. Usually, E_o is approximately 0.66 V.[4]

In addition to interfacial recombination caused by TCO, another effect is that thermal electron emission from the TCO film further increases the saturation current I_o of the cell. This is analogous to the thermal emission current of a metal semiconductor.[5] This current not only lowers the V_{OC} but also affects the FF of the cell.

Another issue is indium diffusion which lowers the effective dopant concentration in the p region and increases the carrier concentration in the intrinsic layer. A double layer of ITO/SnO_2 or a single layer of SnO_2 is

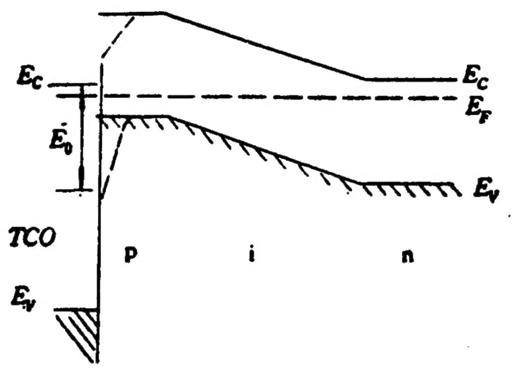

Figure 1. Barrier E_o at the Interface Between TCO and paSi:H

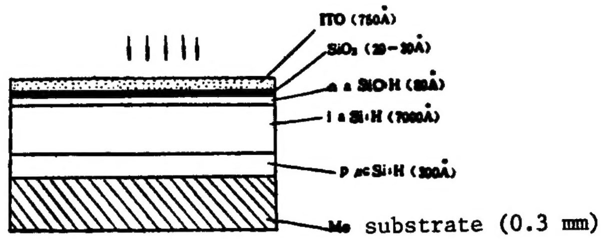

Figure 2. Sketch of the Experimental Cell

used as the top layer. However, because SnO_2 is also heavily doped (by F or Sb), similarly interfacial recombination is a problem that cannot be overcome. From semiconductor device theory, surface passivation is an effective way to reduce surface state density and lower interfacial recombination current. Wolf[6] discussed this problem from a theoretical standpoint. M. A. Green[7] in Australia employed SiO_2 as passivation layer for a single crystal silicon cell with 20 percent efficiency. This paper will discuss the experimental results involving the use of a reactively deposited SiO_2 film for surface passivation.

Inside a homogeneous semiconductor in equilibrium, it is electrically neutral and there is no electric field. However, it is quite different near the surface. The thin space charge layer beneath the surface has uncompensated charges and there is an electric field, creating surface states and surface recombination. If a layer of SiO_2 is deposited on a clean surface of a semiconductor, then most of the unsaturated dangling bonds are compensated by the Si atoms in the oxide layer. Thus, the recombination rate at the interface between SiO_2 and amorphous silicon is reduced. Most semiconductor devices have improved characteristics after adding this passivation layer. Furthermore, SiO_2 also has excellent transmittance and density. It can block the impurities in TCO from entering the top layer semiconductor. Takao, Naga and Tomo improved the performance of a SnO_2SiO_x/m-Si cell on a single crystal substrate by using SiO_x as a passivation layer.[8]

II. Optimization of Boron-Doping of Intrinsic Layer

Doping the intrinsic layer with minute amount of boron is an important way to raise its electric field strength to overcome the lack of an electric field. We have reported some relevant results[9] which showed a reduction of charge density in the space charge region to $9 \times 10^{14}/cm^3$. This value is half an order of magnitude higher than that reported in reference 10 for a cell with 11.7 percent efficiency. Reference reported that the optimal dopant concentration in the i layer is 3-5 ppm. In reality, this number is primarily determined by the fabrication technique of the film, the geometry of the electrode used for deposition and the gas flow distribution. The results and discussion will be presented later.

III. Structure and Fabrication of Experimental Cells

1. Cell Structure

The cell was prepared in a single chamber by RF glow discharge decomposition of silane. A transverse electric field was used to decompose the reactant. The cell was placed outside the plasma to minimize radiation damage on the film from charged particles. A special gas flow pattern and electrode arrangement was used. The optimization of the system was described in an article published earlier.[12] The structure of the cell is shown in Figure 2.

2. Preparation of ITO Film

A mixture of indium oxide and tin oxide (9:1) was deposited by electron beam evaporation. The substrate temperature was 230-250°C, the electron beam power was 6000 V x 40 mA, and the deposition rate was 1.25-1.5 Angstroms/s. The film has a 93 percent transmittance (at 4500 Angstroms) and the thin film resistance is 20 Ω-cm.

3. Preparation of SiO_x (x 2) Passivation Layer

People usually use CVD, LPCVD, or PCVD to prepare SiO_2 film. Nevertheless, these methods are not suitable for the formation of SiO_2 film on amorphous silicon because these techniques require a high substrate temperature which could rapidly drive off the hydrogen in the film. Moreover, the SiO_2 film formed by thermal oxidation of a doped film actually contains high levels of impurities such as P and B. This effect would produce opposite charges on the surface to further complicate the interface. It is more appropriate to use vacuum electron beam reactive deposition of SiO_2. The basic technique is as follows:

Background vacuum: 1.2×10^{-3} Pa
Deposition vacuum: 5×10^{-2} Pa (filled with gas)
Substrate temperature: ambient temperature
Evaporation source: pure SiO semiconductor

The oxide film thus produced was found to have an index of refraction of 1.5. The index of refraction of a conventional SiO_2 film is 1.46.[13] This indicates that $x \rightarrow 2$ in SiO_x. SiO_2 has excellent short wavelength transmittance. Figure 3 shows transmittance as a function of wavelength for ITO/SiO_x, ITO/SiO and ITO/SnO_2 films. We can see that ITO/SiO_2 has better characteristics and ITO/SiO has much lower short wavelength transmittance. By measuring the basic property, the behavior of reactively deposited SiO_x is close to that of SiO_2. The key to obtaining SiO_x ($x \rightarrow 2$) is controlling the deposition rate.

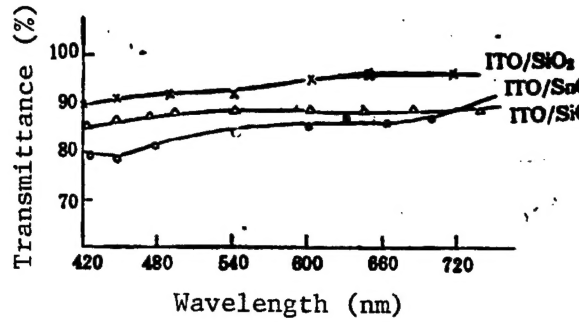

Figure 3. Transmittance of ITO/SiO_x, ITO/SiO and ITO/SnO_2 Films

The thickness of SiO_x is a major factor affecting the behavior of an amorphous silicon solar cell. Excessively thick film will raise the serial resistance of the cell. Table 1 shows relation between SiO_2 film thickness and some cell parameters. We can see that when the oxide layer exceeds 32 Angstroms, cell performance begins to deteriorate. This is because SiO_2 is a very resistive medium and charge carriers cannot penetrate it when it is too thick. Therefore, the cell performs better when this film is less than 30 Angstroms thick. From the standpoint of the diode saturation current I_o, it is also a function of SiO_2 thickness after the cell is passivated. However, it is not easy to control in process when it is less than 20 Angstroms thick.

Table 1. Relation Between Oxide Film Thickness and Cell Behavior

Parameter	I_{SC} (mA)	V_{OC} (V)	FF (%)	η (%)	Saturation current I_O (A/cm^2)
Thickness (Angstrom)					
88	1.28	0.663	< 20	< 1	1.25×10^{-11}
57	2.96	0.666	35.5	3.08	1.38×10^{-11}
32	3.32	0.820	54.0	6.71	8×10^{-11}
24	3.30	0.800	60.4	7.10	2×10^{-10}
25	3.68	0.830	62.95	9.0	2.8×10^{-10}

Experimental cell is 0.5×0.5 cm^2

In order to further verify the effect of the oxide layer on the behavior of the cell, two identical sets of n-i-p cells deposited at the same time on molybdenum substrate were used in the following experiment. One set of cells had an ITO surface layer and the other had an ITO/SiO_2 top layer. The thickness of SiO_2 is 25-30 Angstroms. The I_o values of these two cells are reported in Table 2. The cells with the SiO_2 passivation layer showed better uniformity. The efficiency is over 7 percent and the I_o ranged between 10^{-9}-10^{-10} A/cm^2. Of course, it is also possible to build a good solar cell without ITO/SiO_2. Nevertheless, the uniformity is much lower. The highest efficiency on the same piece of substrate was 7.25 percent. However, it was 4-5 percent for most cells. The value of I_o is two orders of magnitude higher. This experiment demonstrated the non-uniformity of the surface state on amorphous silicon. The use of a SiO_2 passivation layer could significantly improve the uniformity of the cells and their efficiency. This is primarily because the Si in SiO_2 can bond to the dangling bonds on the surface of amorphous silicon to reduce the surface states and lower interfacial recombination. On the other hand, SiO_2 also limits the emission of thermal electron to drive the saturation current of the cell down. This also improves the performance of the cell.

Table 2. Effect of Oxide Film on Cell Behavior and I_o

Parameter	I_{SC} (mA)	V_{OC} (V)	η (%)	Saturation current I_O (A/cm^2)
Cell				
015-18/SiO_2	3.85	840	7.7	2×10^{-10}
015-22/SiO_2	3.80	842	7.4	2.43×10^{-9}
015-10/SiO_2	3.84	840	7.3	5.27×10^{-9}

Table 2. Effect of Oxide Film on Cell Behavior and I_o (Continued)

Parameter	I_{SC} (mA)	V_{OC} (V)	η (%)	Saturation current I_o (A/cm^2)
Cell				
015-21/SiO_2	3.76	842	7.2	7.9×10^{-9}
015-20/SiO_2	3.56	838	7.15	4.93×10^{-9}
015-9	4.0	838	7.25	6.59×10^{-9}
015-7	3.16	812.6	5.72	9×10^{-9}
015-5	3.14	812.6	4.7	1.42×10^{-6}
015-6	2.72	805.2	4.1	1.01×10^{-8}

SiO_2 represents cell with a SiO_2 passivation film. Cell area is 0.5×0.5 cm^2.

4. Optimization of Boron Doping for the Intrinsic Layer

In either n-i-p or p-i-n cell, the effect of doping of the i layer with a minute amount of boron on the performance of cell is an issue. The high charge density in the i layer is the principal reason for the absence of an electric field. It is believed that the FF of an amorphous silicon cell is primarily determined by the charge density of the i layer.[9] A suitable boron level is determined by many factors such as gas flow pattern in the reaction chamber, electrode structure and relative position of the substrate.

Figure 4 shows the FF, I_{SC} and cell efficiency η as a function of boron level. At 0.4 ppm, the activation energy of the i layer is 0.86 eV. This indicates that the Fermi level has already been moved toward the middle of the energy band. Without boron, its activation energy is 0.598 eV, which is approximately 0.2 eV higher than the center of the band gap. If excessive amount of boron doping is used, the film is p type and its activation energy is 0.65 eV. From Figure 4, it was found that our experimental results are quite different from what was reported in reference 11. Based on this finding, the carrier concentration in the i layer of cells fabricated decreased further. Figure 5 shows the carrier concentration distribution inside cell number 80. Based on an analysis,[9] there is an improvement compared to the carrier distribution inside the most efficient cell made in the past. The lowest carrier concentration in the i layer is $6.5 \times 10^{14}/cm^3$.

5. Surface Texturing and p_CSi:H Film Preparation

The electrical conductivity of $p\mu_C$Si:H film has been raised to 1 $(\Omega\text{-cm})^{-1}$ and its activation energy is as low as 0.052 eV. This increases the electric field strength on either side of the i layer. The optical band gap of the naSi:H film is 2.4 eV. CH_4 was used as the carbon source at 50 percent.

IV. Results and Discussion

Cells were treated at AM 1.5, i.e., 100 mW/cm^2, light (Note: Compared to SERI's test method, there is only a +/- 3 percent difference. Refer to SERI, Devices Report No 334, 1985). Tables 3 and 4 show the test results. The highest efficiency of 0.5×0.5 cm^2 cells (effective area) is 10.42 percent. Compared to the results reported in reference 9, efficiency was improved by 15.5 percent, FF was raised by 8.33 percent, I_{SC} was increased by 11.47 percent, and V_{OC} went up by 1.7 percent. The efficiency of 1×1 cm^1 cell is as high as 8.02 percent.

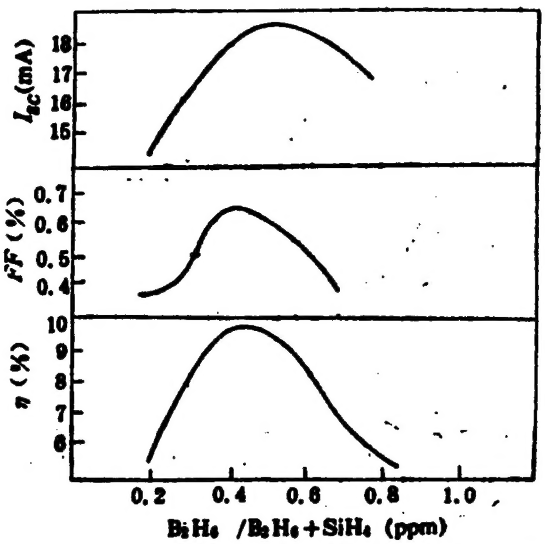

Figure 4. Boron Doping Level vs. Cell Performance

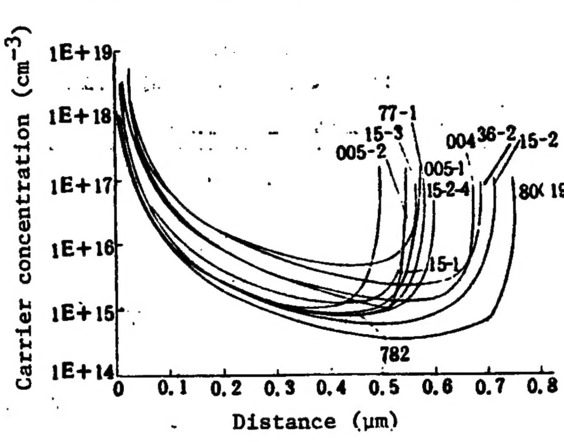

Figure 5. Carrier Concentration Distribution in an Experimental Cell

Table 3. Test Results (AM 1.5, 100 mW/cm², 29°C

Parameter	I_{SC} (mA)	V_{OC} (V)	FF (%)	η (%)	Effective area (cm²)
Cell					
1	3.730	0.840	65.80	9.16	0.225
2	3.640	0.837	56.66	7.66	0.225
3	3.730	0.833	63.80	8.81	0.225
4	4.640	0.810	58.22	9.35	0.225
5	4.548	0.850	58.32	10.02	0.225
6	4.220	0.855	64.90	10.42	0.223

Cell area is 0.5 x 0.5 cm²

Table 4. Test Results (AM 1.5, 100 mW/cm², 29°C)

Parameter	I_{SC}	V_{OC} (V)	FF (%)	η (%)	Effective area (cm²)
Cell					
1	16.40	0.800	61.50	7.30	1.0
2	16.14	0.800	62.10	8.02	0.9
3	16.36	0.822	43.30	5.84	
4	16.20	0.810	49.84	7.26	

Cell area is 1 x 1 cm²

Figure 6 shows typical photo-current vs. bias curves under forward and reverse bias upon illumination by monochromatic light. If there is a region in the i layer without any electric field, and if there is a great deal of recombination between ITO/naSiC:H, then the photo-current would increase dramatically under a reverse bias upon illumination with 4430 Angstroms light. Otherwise, there is no apparent effect. This is a convincing evidence that a SiO_2 passivation layer can improve the recombination at the top interface and limit the thermal emission current I_o. The highest efficiency cell was measured to have $I_o = 3 \times 10^{-11}$ A/cm². This is two orders of magnitude lower than that without having a SiO_2 passivation layer.

Experimentally, it was found that a minute amount of boron doping of the SiO_2 and intrinsic layer has little effect on V_{OC}. This is because amorphous silicon has a wider band gap. V_{OC} is primarily determined by the Fermi levels of both n and p type layers.

In other countries, SnO_2:F or ITO/SnO_2 is used as the conductive layer. The thickness of SnO_2 is 200 Angstroms. We use SiO_2 as an intermediate layer between ITO and naSiC:H to reduce surface recombination. Can it stop In atom from diffusion from ITO toward nSiC:H? This problem needs to be further investigated. Based on our analysis of the experimental data, in a n-i-p cell with a post-deposited conductive film, because of low substrate temperature and short deposition time, In diffusion does much less harm that that in a p-i-n cell on a

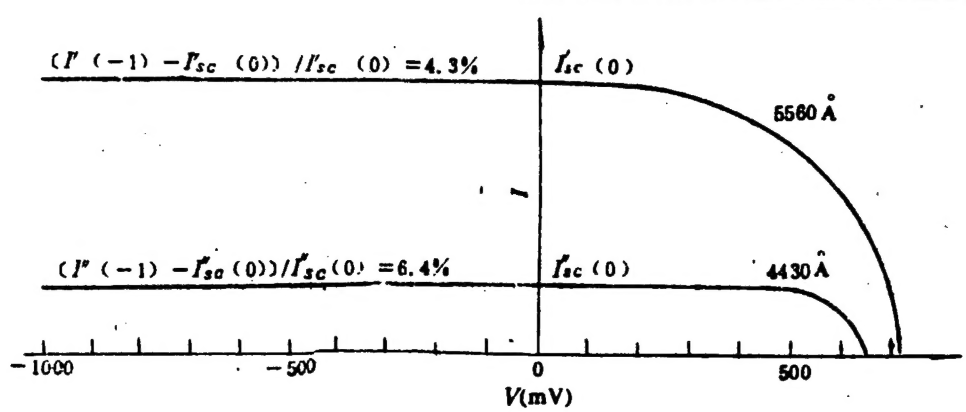

Figure 6. I-V Characteristics of Cell No 15-2-4 Under Monochromatic Light (at 5560 Angstroms and 4430 Angstroms)

glass substrate. Therefore, interfacial recombination becomes the principal factor.

There are 17 research institutes and corporations that have fabricated experimental devices with over 10 percent efficiency.[14] The largest area is 1.05 cm^2 and the smallest is 0.033 cm^2. Six of them have efficiency below 10.4 percent. As far as efficiency is concerned, the device we constructed has already achieved a very high level. The main gap is FF. The authors believe that the photo-electronic property of the intrinsic layer and interfacial recombination are still the principal issues.

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Application of LANDSAT Imagery in Petroleum Geology

906B0079A Jiangling SHIYOU YU TIANRANQI DIZHI [OIL AND GAS GEOLOGY] in Chinese Vol 11 No 1, Mar 90 pp 114-116

[Article by Ji Yanpeng [0679 6056 7719] and He Qingzhi [0149 1987 1807], Comprehensive Research Institute of Petroleum Geology, Ministry of Geology and Mineral Resources]

[Text] Abstract: The authors reviewed the achievements they have made in using remote sensing to study petroleum geology. This technique has played an important role in hydrocarbon exploration in Tarim and other basins.

The Comprehensive Institute of Petroleum Geology of the Ministry of Geology and Mineral Resources imported the remote sensing technology in 1978 and established a laboratory of remote sensing geology. With the support of the leadership, an approach was taken to combine remote sensing with physical exploration, chemical exploration and geological survey and form a comprehensive team. Research of a number of topics has been developed to exploit the spectral data of typical ground objects, image analysis, and optical image enhancement. From 1979 to 1980, the Ministry of Geology and the Ministry of Petroleum Industry jointly formed a remote sensing team for the geological survey of the Tarim Basin. Our institute wrote the final report, "Petroleum Geological Interpretation of Satellite Photographs for the Tarim Basin." Subsequently, we conducted detailed remote sensing geological surveys of southwest Tarim and published the report, "Detailed Interpretation of Satellite Photographs for Southwest Tarim," for the work conducted in the 1980 to April 1981 period. We participated in the Chinese-Japanese joint effort remote sensing geological survey of Ordos Basin and the writing of the report "Interpretation of LANDSAT Imagery of Ordos Basin" (August 1982 to April 1983). In another Chinese-Japanese cooperative geological survey, we made additional ground object spectral measurements in northern Ordos Basin and reported the results for the June 1983 to March 1984 period in "Final Report on the Spectral Measurement of Typical Ground Objects in Northern Ordos Basin and Its Application in the Petroleum Geological Interpretation of LANDSAT Imagery." Specialists of sedimentation phase and organic earth chemistry of our institute have also conducted remote sensing of the Yining Basin and contributed to the report "Preliminary Report on the Carboniferous Permian Gas and Oil Prospects in the Yining Indentation" (1983-1984). We have also conducted remote sensing geological survey of the Carboniferous Permian system in the Turpan and Hami region. By combining our sedimentation phase data and gas and oil data with the gas and oil data cumulated by the Northwestern Petroleum Geology Office, we compiled the report entitled "A Preliminary Study of the Gas and Oil Prospect in the Turpan-Hami Region Carboniferous Permian System" (1985-1987). In 1986-1987, we were assigned the task of applying LANDSAT data to petroleum geology. We used computer image processing, laboratory decoding, field survey, and computer correlation of different data, and produced the report "Petroleum Geological Interpretation of LANDSAT Photographs of the Northern Tarim Basin Territory" (1986 to April 1987). In addition, we also assumed the responsibility for surveying the Mesozoic era geology of the Badan Jaran-Tenger region. We have now completed the

report "Preliminary Analysis of the Gas and Oil Prospects for the Mesozoic Geology in the Badan Jaran-Tenger Region" (April 1987 to October 1989).

After years of experiment and research of petroleum geological remote sensing, new advances and good results have been obtained in the petroleum geological studies and regional geological research by remote sensing techniques. Procedures and methods have taken form.

The object of study in petroleum geology are gas and oil basins. Specific contents include the analysis of the basin structure, topographic and water system characteristics of the basin and the surrounding region, the extent of the basin, the boundary conditions of the basin, the growth of faults and closures (with possible hidden structures) in the basin, sedimentation from the various eras in the basin, geochemical characteristics of the gas and oil, and finally, an evaluation of the gas and oil prospects and the prediction of the target zone based on a comprehensive analysis of the structure, sedimentation, and gas/oil data. We realize that the main role of remote sensing in this process is to provide data for the basin structure analysis. For example, the area of the Tarim Basin is 56 x 10^4 km^2, with vast desert coverage, and surface geological work is difficult. However, a mosaic of satellite photos for the Tarim Basin is like a geological model that clearly reveals the ridges, valleys, water systems, strata and other structures. The light-colored, diamond-shaped basin is surrounded by the darker-colored, striped mountains of complex structure. In front of the mountains are diluvial and alluvial fans of various sizes. Ground water seeps out at the edges of the fans to form a ring-like water system. The vast back land is covered by desert and the basin is cut by two north-south running rivers into three sections. The Mazartag mountains, running east-west, cut across the basin west of the Hetian River. These ground features are the products of their respective geological era and help us pinpoint the boundary of the basin. They also provide important data about the geological evolution of the basin and aid the analysis of the regional structure. We interpreted the exposed strata around the border of the basin and compiled geological graphs. We identified 93 major line images, including 40 faults and 27 possible hidden rifts, and 26 linear image anomalies. These fault images show pronounced regularity. In the west and north parts of the basin, northwestern running faults appear with almost a regular spacing; in the southern part of the basin the fault images are mainly in the northeastern direction. The No 41 fault image (Qieshi-Yuepuhu-Shache) has a northwest orientation and a total length of 217 km. For structure classification purposes, the No 41 fault may be regarded as the dividing line between the southwest indentation of the basin and the Maigaiti slope. The No 57 fault image (the Qunke-Altan fault) starts from Qunke in the west, follows the Tarim River along the southern border, and extends toward Altan in the southeast. The fault is oriented in the northwest direction and has a total length of 147 km. The identified features are clear and may serve as a boundary between the Peacock River slope and the eastern indentation. The goal of interpreting the circular images is to search for oil storage structures. Within the basin 182 major ring images were identified, including 54 surface structures, 3 newly discovered surface structures, 51 ring images that may reflect hidden structures. Among the latter, 34 agreed or partly agreed with physical survey results and 17 possessed positive ground morphological characteristics. It is significant that No 168 ring image (Yuchiaiken) with an orientation of 70° and an area of 70 x 9 km^2 coincided largely with the Ya-ke-la structure encircled by the Paleozoic top surface (T^{o}_{5}). It was on this very structure that Sha-can No 2 and other wells produced high yield gas and oil flow. Attention should also be given to the No 100 ring because it coincides with the structure encircled by the earthquake reflecting layer.

Based on LANDSAT image interpretation results and geological and physical survey data, we proposed the regional structure characteristics of the diamond-shaped Tarim Basin. Among the structural lines of the region, the east-west lines are the oldest and the north-east lines are the next; they control the distribution of the pre-Mesozoic erathem sedimentation. The north-west lines are the newest and may control the sedimentation of the Mesozoic erathem. Based on the analysis, we reported for the first time the profile of the [Ke-tu-er]-[Lun-tai] swell and pointed out that it was controlled by the east-west structural line. This viewpoint has now been verified and this swell is one of the main targets of the Tarim Basin for gas and oil.

The results of other research topics will not be presented here; we shall only explain some new understanding based on the interpretation of the LANDSAT imagery. For the Yining indentation, physical survey data are very sparse, the satellite imagery results therefore became the main data base for structural classification in the indentation. Based on the LANDSAT image interpretation, we broke away from the conventional wisdom and pointed out that the Turpan-Hami Basin was really a part of the Jungar Basin and only later broken up by the Bo-ge-da mountains. Today's Bo-ge-da mountains were underwater swells in the early Carboniferous epoch, they became geosynclinical anticlinorium in the mid- and late-Carboniferous epoch, and began to swell in the Permian period to form the embryo of the Bo-ge-da mountains. Using a combination of the LANDSAT image data and the known geological and physical survey data, we classified the structural units in the Turpan-Hami Basin. Based on the geochemical data on the sedimentation phase and oil gas, we have also evaluated the north Turpan indentation as having the best prospects for oil and gas, followed by the Hami indentation. This evaluation has now been proven correct; the Ministry of Energy has discovered industrial oil/gas flow. In the Ordos Basin we have not only identified numerous faults running east-west and north-south based on satellite images and confirmed the existence of the north-east fault, but also for the first time interpreted the periodic

north-west faults. Based on these structure configurations, we proposed new interpretations of the structure. After comprehensive analysis, we believe that structural lines running east-west and north-south are the oldest, followed by north-east structural lines, and the north-west lines are the newest. We also pointed out the importance of finding oil and gas reserves in the northern half of the Ordos Basin and provided a motivation for seeking oil and gas in the Ordos Basin.

To further develop LANDSAT imagery research, we should build on experience and improve the effectiveness of LANDSAT imagery interpretation. We recommend the following efforts:

1. Improve the optical enhancement of satellite images and the resolution of the pictures. Computer image processing should be used for specific purposes and appropriate methods should be used for optimum results.

2. Combine remote sensing and chemical survey, explore direct methods to seek oil and gas indicators, and study the formation mechanism of LANDSAT imagery anomalies. As petroleum survey continues, it becomes more and more difficult to discover surface indications of oil and gas. Satellite image anomalies and chemical survey anomalies both reflect geochemical characteristics and must be related. By combining the two, the best results can be obtained in the search for surface indications.

3. Comprehensive analysis based on a combination of remote sensing and geological, physical survey results have been proven successful. No single method is the answer to everything and each method has its advantage. Remote sensing is no exception. Years of experience have shown that comprehensive analysis of the remote sensing data and the physical survey and geological data produced more realistic evaluations. In the beginning we only mechanically overlapped the image data and the accuracy was relatively poor. Now, with computers doing the comprehensive analysis of all the data, the accuracy has been much improved.

Zhejiang Power Industry Update

40100001C OW0310155990 Beijing XINHUA in English 1505 GMT 3 Oct 90

[Excerpts] Hangzhou, October 3 (XINHUA)—Electric power generating capacity has reached 5.61 million kW in Zhejiang Province. [Passage omitted]

The provincial power bureau reported that the coastal province has built a number of large power plants along the coast in recent years.

Among them, the Zhenhai Power Plant has an installed capacity of 1.05 million kW. The Beilungang Power Plant in Ningbo City has a design capacity of 2.4 million kW, the largest in south China. At present, the first generating units with a capacity of 600,000 kW are being installed and will become operational by the end of this year. Construction of the Qinshan Nuclear Power Plant, the first designed and built by China, will be completed early next year.

Meanwhile, more than 6,000 small hydropower stations which produce over 1.8 billion kWh each year have been built. Over 95 percent of rural households now have electricity.

The province has also developed tidal-power generators and a pumped storage power station with a capacity of 1.8 million kW.

Relying on Reform To Speed Up Hydropower Development

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[Article by Minister Huang Yicheng [7806 3015 6134], Ministry of Energy Resources: "Rely on Reform, Accelerate Development of the Hydropower Industry"]

[Text] **I. Hydropower Is One of China's Two Big Energy Resource Advantages**

China has two big energy resource advantages. One is coal and the other is hydropower. Coal is China's main energy resource at present. Coal accounts for three-fourths of our energy resource consumption. We produce over 1 billion tons a year, the largest amount extracted in the world. Given China's present situation, it will be quite hard to change our reliance on coal as our main energy resource for quite some time to come. However, rapid industrial development and population growth are increasing the pressures on coal mining. Moreover, mining large amounts of coal presents two problems. One is that hauling coal over long distances places a heavy burden on railway transport. The second is that environmental pollution from burning large amounts of coal is becoming increasingly serious while international demands for environmental protection are becoming increasingly higher. For this reason, while relying on coal as our main energy resource, China also should increase the proportion of hydropower and nuclear power to fundamentally solve the contradictions between energy resources and transport and between energy resources and the environment.

China has many large rivers, especially in the southwest, with abundant precipitation and large heads. We have over 378,000 MW in developable hydropower resource reserves, first place in the world. Hydropower is clean, non-polluting, and renewable. It is acknowledged worldwide as an ideal energy resource. All the world's developed nations and some developing countries have developed almost all of their usable hydropower resources, which shows that hydropower resources are truly welcomed as an energy resource. Because of insufficient finances and other reasons, however, China has not undertaken work in this area on a large scale and we have enormous potential reserves.

II. Primary Factors Affecting the Speed of Hydropower Development

China's hydropower industry has developed rather quickly since our nation was founded. Shortly after liberation, China had an installed hydropower generating capacity of just 360 MW. This grew to 1,020 MW in the Fifth 5-Year Plan and our present installed hydropower generating capacity is 34,280 MW. It must be said that this speed of development cannot be considered slow. However, from another perspective, the speed of hydropower development in China is not quite ideal. First, compared to development of the national economy, the average rate of increase in gross value of social output in China from 1981 to 1989 exceeded 11 percent while the average rate of growth in installed hydropower generating capacity was 5 to 6 percent. Second, after rising to 30.9 percent in 1975, the installed hydropower generating capacity as a proportion of our total installed power generating capacity hesitated at between 30 to 32 percent for 10 years and declined gradually every year after 1984, dropping by 5 percent over 5 years. Third, the development and utilization rate for China's hydropower resources is rather low compared to other nations of the world. The average for all world nations is 13.54 percent but the figure in China is just 5.7 percent. The capacity we have developed so far is just a fraction of our reserves. In comparison, the development and utilization rate exceeds 50 percent in countries with developable hydropower resources of more than 100 billion kWh a year like the United States, Canada, Norway, Japan, and so on. From the perspective of supply and demand relationships, China has had a universal shortage of electric power and relative shortages of coal and railway transport for quite some time. The cry for major development of hydropower is growing louder. If we work well, China's hydropower industry should develop more quickly.

What is the key to the problem of our less-than-ideal rate of hydropower development? I believe that both internal and external factors are involved here. Some say that hydropower wears three "hats." One is "long schedules." It takes 7 to 10 years to build a hydropower station, so hydropower in the distant future cannot salvage thermal power available in the short term because the wait for power is too long. The second is "high construction costs." The construction cost per kW is about one-half again higher than thermal power and the yearly utilization time is much less than thermal power. The third is "population resettlement problems." These three hats are certainly the main reasons that have affected the pace of hydropower development over the past several years. Thus, we must take off these three hats and develop the hydropower industry more quickly.

III. Take Off the Three "Hats" as Quickly as Possible

We first must take off the "hat" of "long construction schedules." If construction schedules are long, users will not wait and project construction costs will increase. Loan time limits are long and the economic benefits are poorer. In the past, hydropower projects usually took 7 to 10 years and there were even longer "old bearded projects." Must construction of hydropower stations take so long? Can it be shortened substantially? I personally visited Xin'an Jiang Hydropower Station which has 660 MW in nine generators. The project cannot be considered small, and it took just 36 months for the first generator to begin generating power. The whole project was completed in just over 5 years. Zhexi, with an installed generating capacity of 440 MW, was completed in just 28 months. Both were built in the early 1960's, and everyone knows what mechanization levels in construction were like then. With the substantial increase in

mechanization levels now, why are construction schedules even longer? The Ministry of Energy Resources has proposed that shorter construction schedules be the breakthrough point in using energy resources well and that shorter hydropower construction schedules be the breakthrough point for removing the three hats. The most important thing is doing preparatory work well to ensure that capital, materials, equipment, and design materials arrive on time after construction begins. Construction should not begin unless these conditions are implemented, and once construction begins we should have a sufficient number of shifts, work day and night, fight for every minute and second, and always maintain tight and procedural construction. The second thing is to deal properly with local areas and try as hard as possible to foster local initiative. Some projects can be handled mainly by local areas. In the Geheyan project, for example, the provincial governor was frequently involved and the project proceeded smoothly. Third, we should reinforce management by studying the management patterns of Lubuge, for example, to scientifically and rationally arrange construction, have few but highly-skilled leading cadres, implement responsibility systems down to each cadre and worker, take full advantage of political work, motivate the initiative of cadres and workers, resolutely pay according to the amount of work, reward diligence and punish laziness, and so on. Fourth, projects with suitable conditions can study generating power ahead of schedule during construction. In general, it is possible to reduce the construction schedule for the main part of a 1,000 MW-grade hydropower project to under 4 years.

The second hat is "high construction costs." Both external and internal factors are involved here. The large amount of earthworks involved in a hydropower project means that unit construction costs are usually about one-half higher than thermal power. Because the number of yearly utilization hours is also about one-half less than thermal power, investments per kWh for hydropower compared to thermal power for the power station itself are about double. However, thermal power requires burning coal and coal must be transported, so investments in coal mining and investments in railways and harbors must be included. According to estimates based on relevant information, the unit investment for thermal power is about 80 percent the unit investment for hydropower. This means that unit construction costs for hydropower are only slightly higher than thermal power. If we select sites well and adopt effective measures in design and construction, we can remove the hat of high construction costs. The range of things involved in reducing construction costs is very broad and everyone should attempt it.

It should be pointed out here that making full use of advanced S&T achievements plays a prominent role in reducing construction schedules and lowering unit construction costs. Examples include adopting advanced types of dams, selecting optimum designs, extending rolled-concrete large dam construction technologies, focusing on large cross-section tunneling equipment and technologies, and so on. Construction schedules for hydropower stations are very long and many things can be done to adopt measures for temporary power generation during construction.

The third hat is "population resettlement problems." Excluding runoff-type stations, any hydropower station with reservoir capacity requires flooding some land. Solving population resettlement problems in inundated regions is rather difficult. The method used to resettle people in the past was simply to help them settle down. The peasants were given a little money and the government did not care how they spent it. Some built houses but had no land or means of livelihood. Others ate well and spent all their money and then did not even have houses, and would come back again to ask the state for money. This was not a method. Premier Li Peng pointed out the need for development-oriented population resettlement. This means that the money should be spent mainly for economic development to open new avenues of production for the people resettled or arrange formal jobs for them. Examples include guiding them to reclaim wasteland and plant citrus trees, recruiting workers from the reservoir region to run small factories, and so on. These population resettlement funds must be given to the peasants in person through direct signing of contracts. They cannot be carried off by intermediaries and used for their own purposes. In summary, hydropower construction must be integrated with economic development in the reservoir region. This can substantially reduce the difficulty of solving population resettlement problems.

IV. Rely on Reform and Policies, Raise Hydropower Construction Capital From Many Areas

To have major development of hydropower, we must also solve the problem of construction capital. Solving this problem will be quite difficult if we do not rely on reform and policies. First, we must change the method of hydropower relying mainly on state finances as a source of funds and establish stable construction funds. Of course, with a prerequisite of gradual improvements in state finances, we should increase investments in hydropower as appropriate, but it would still appear that we must establish a hydropower construction fund outside of state finances. By deducting 0.02 yuan per kWh from the amount of power generated by hydropower, and with a prerequisite of persuading provinces, municipalities, and autonomous region to make no changes in ownership rights, it should still be invested in hydropower construction. Hydropower is now generating over 110 billion kWh of power annually, so this could raise over 2 billion yuan in funds. Second, for large and medium-sized hydropower stations that have already been completed and gone into operation, when the original investment came from bank loans, the interest should be repaid to the banks, but the recovered principal should be used again to develop hydropower. In those cases involving a shift from allocations to loans, all recovered principal should be invested in hydropower

development. Third, raise funds from the profits of some existing hydropower stations. For example, do cascade development of Hongshui He and, after the Yantan and Tianshengqiao Second Cascade power stations begin operating, we can have independent accounting for new hydropower stations that go into operation. Higher electricity prices should be set according to the principle of loan repayment capabilities and it should be sold to the more developed regions of Guangdong and Guangxi. In this way, more investments can be raised to build Longtan Power Station.

Hydropower stations require no fuel, so they have the lowest operating costs. In principle, they should earn more money than thermal power plants. For China as a whole, the actual situation is the same. In the Northeast China Grid, for example, thermal power predominates, and it can earn just a few billion yuan. The Sichuan Grid, which is not considered to generate large amounts of power, turns over more to higher authorities than the Northeast China Grid. A hydropower station, however, does not earn much money and banks may even be unwilling to provide loans. The reason is that power stations sell electricity to grids at low prices, so everyone eats from the big common pot and there is no clear distinction between those earning money and those losing money. The Ministry of Energy Resources has already decided to use reform as a way to solve this problem. New hydropower stations going into operation will practice independent accounting and grids will only collect management fees. This will truly foster the benefits of hydropower and there will be no loan repayment problems. This will create the conditions for raising capital and increasing the self-development capacity of hydropower.

V. There Should Be Major Reforms in Hydropower Construction Staffs

China now has over 20 rather large hydropower construction staffs with 270,000 people. Each construction staff has a full complement of people, and there is serious idleness and very heavy economic burdens. Staffs with fuller construction tasks can only pay a portion of their wages and staffs with insufficient tasks are in even worse straits, some not even paying wages at all. I feel that there is a significant relationship between the problems of hydropower construction staffs and the unsuitability of their organizational forms to the characteristics of hydropower construction. It is quite hard to make balanced arrangements for hydropower construction projects and their scales, and it is quite hard to make balanced arrangements for excavation, pouring, installation, and other work procedures for each project itself. When concrete is being poured, excavation and installation workers have insufficient tasks. Thus, there should be major reforms. One is gradually reducing personnel. Basic staffs should keep key workers and maintain crack troops and leaders. This will keep them busy when there are few tasks and they can recruit temporary workers and contract workers when they have more tasks. The wages of these workers should be much higher than formal workers, but we should not be responsible for taking care of their duties nor should we bear the burden of making arrangements for their relatives, housing, study and employment for their children, or retirement of old workers. Such construction staffs can have people entering and leaving, can vary in size, and will have much stronger sustaining and competitive abilities. Second, we should gradually shift from comprehensive staffs to specialized staffs. For example, on the basis of existing specializations in each project bureau, we should organize open excavation, tunnel excavation, concrete pouring, equipment installation, and other specialized staffs and outfit them with the necessary specialized construction equipment to increase work efficiency and quality. Third, establish base areas, consolidate reserves, develop tertiary industries, stabilize staffs, and increase coherence.

The difficult situation hydropower construction staffs now face has been around for over 10 years and it will be extremely difficult to reform them. Without reform, however, there is no way out, so we must continue our determination.

VI. Hydropower and Thermal Power Require Mutual Regulation, Unified Planning, and Coordinated Development

Compared to thermal power, hydropower has the prominent advantages of not requiring fuel, being clean and non-polluting, renewable, and so on. However, it also has the disadvantages of depending on the heavens for its existence, an inability to generate power without water, lower annual hourly utilization times, and so on. This is even truer for runoff hydropower stations and small hydropower stations. For example, Guangxi's Dahua Hydropower Station has an installed generating capacity of 400 MW but its guaranteed output during the dry season is just 90 MW and there are several days during the flood season when it cannot generate power (the difference between upstream and downstream water levels is zero), and it must also consume 20 MW of power to protect its generators. Grids with higher proportions of hydropower stations have extreme power shortages during dry seasons. If they lack a specific amount of thermal power for regulation, the entire grid may not last. For this reason, besides ensuring that grids have a specific proportion of thermal power installed generating capacity, we should also be concerned with matchup of a grid's hydropower proportions of large, medium-sized, and small hydropower stations as well as runoff hydropower stations, power stations with reservoir capacity, and key power stations and be concerned with rational cascade development of an entire river basin to achieve unified planning and coordinated development.

Second Cascade of Wu Jiang Development Scheme Highlighted

906B0080B Beijing SHUILI FADIAN [WATER POWER] in Chinese No 5, 12 May 90 pp 7-10

[Article by Liu Ying [0491 4431]: "Second Cascade To Develop Wu Jiang—Design and Construction of Dongfeng Hydropower Stations"]

[Text] **I. Overview**

Another large hydropower station to be built in China's karst region, Dongfeng Hydropower Station, is located on Yachi He at the boundary of Qingzhen and Qianxi Counties in Guizhou Province. It is the second cascade hydropower station on the trunk of the Wu Jiang (the first cascade is Hongjiadu Hydropower Station, which is in the initial design stage and the fourth cascade is the already-completed Wujiangdu Hydropower Station). The main function of Dongfeng Hydropower Station will be power generation. It is 88 kilometers from Guiyang City, Guizhou's load center, and it has convenient communications and transportation.

The normal water storage level in the hydropower station's reservoir is 970 meters and the elevation of the dam crest is 978 meters. The reservoir capacity is 1.025 billion cubic meters. It is a reservoir without year-round regulation. The power station's installed generating capacity is 510 MW and its guaranteed output is 110 MW during independent operation. The long-term average yearly power output is 2.42 billion kWh and the yearly utilization time is 4,750 hours. The range of the power station's power supply after it is completed will be mainly Guizhou Province and it will be connected to the Sichuan Grid for joint operation.

The key facilities at the power station are composed of four parts: a concrete dual-arch dam in the middle of the riverbed, a flood discharge system on the left bank, an underground plant building on the right bank, and a curtain grouting leak prevention system for the plant building, dam, and reservoir region. Guiyang Hydropower Survey and Design Academy has overall responsibility for designing the power station (South-Central Hydropower Survey and Design Academy is responsible for the underground plant building design). The Ninth Hydropower Engineering Bureau is responsible for construction. The project design employs many design programs and theories developed in China and foreign countries. To meet project quality and progress requirements, units responsible for construction adopted new construction techniques and strict construction technologies and management.

After construction of the power station began in 1984, the relevant units carried out design optimization in several areas for the main project and received guidance and advice from leaders and experts in the relevant areas from China and foreign countries. Design reinspection was carried out in September 1987, and design optimization and construction consulting for the type of the arch dam was again carried out in May 1988. The optimized design for the flood drainage system configuration passed examination in July 1989. During this process, geomechanical simulation experiments for the stability of the dam abutment and three-dimensional photoelastic structural simulation experiments and finite element stress analysis for the underground chamber were carried out. Research was also done in conjunction with state attacks on key S&T topics during the Seventh 5-Year Plan on concrete dam cracks and their prevention, utilization of concrete raw materials, mixing ratios, mixing in large amounts of powdered coal ash, and so on in the Dongfeng project. These optimized designs and scientific experiment and research work in many areas played a substantial promoting role in construction of Dongfeng Hydropower Station.

The primary rock strata in the dam region are Yulong Shan limestone and Yongningzhen group limestone. Karst leakage problems on the right bank of the reservoir mainly occur in the Yulong Shan limestone and they have basically been clarified through many years of survey and design work. Thus, all the key structures are located on Yongningzhen limestone. Primary engineering geology conditions: Outcropping on both the left and right banks are (1)-(4) muddy interbeds. The F_{34} fault on the right bank easily forms rather unstable triangular rock bodies with the (3) and (4) muddy interbeds. The deformation modulus of the rock strata above an elevation of 955 meters on the left bank and at an elevation of 920 to 932 meters on the right bank is rather low. There is a 20-meter-deep trench on the left bank of the riverbed. Two groups of NEE and NWW [as published] structural cracks have substantial effects on anti-slip stability. The F_{34} fault which cuts across the underground plant building is the primary structure. The dam region basically is located between the upstream F_7 fault and the F_{34} fault. The flood drainage configuration should prevent washouts of Jiujitan shale downstream from the dam.

II. Composition and Design Characteristics of Key Structures at the Power Station

1. The concrete arch dam is a parabolic dual-arch dam with an asymmetrical configuration. The maximum dam height is 173 meters (the dam foundation is in a 20-meter-deep trench on the left bank). The dam crest is 6 meters across and the bottom width of the arch cap is 25 meters. The arc of the dam crest curves upstream 259.35 meters and the central angle is 64.56° to 94.1°. The thickness/height ratio is 0.163, so it is a very thin arch dam among arch dams under construction and already completed in China. "Flattening, limited inlaying, and thinning" measures were adopted in the optimized design for the arch dam shape to reduce the depth of dam abutment inlaying on both banks. The depth of inlaying of the upstream dam abutment is 13 to 33 meters and the depth of inlaying of the downstream dam abutment is 22 to 38 meters. The maximum primary pressure stress value is 6.68 MPa and the maximum primary tensile stress value is 0.89 MPa. The dam crest has four surface

holes (11 meters across) and there are two 5 x 6 meter and one 3.5 x 4.5 meter middle holes at an elevation of 890 meters in the body of the dam. Besides flood drainage, the middle holes are also used to flush silt. The amount of excavation for the dam foundation after optimization is 373,400 cubic meters and the amount of concrete used in the dam is 483,000 cubic meters.

2. The flood drainage system, after optimization of the configuration design, has one flood drainage tunnel (12 x 17.5 meters in cross-section, 441.5 meters long, with a longitudinal slope of 0.0665) and one spillway (15 x 20 meters in cross-section) on the left bank. In the preliminary design stage, there were two 12-meter-wide spillways, but the development of load-off cracks on the left bank would make it very difficult to excavate the width of the foundation baseplate on the bedrock of the steep left bank and construction would be difficult. After revision of the flood drainage system configuration, the center line was shifted 3 meters closer to the mountain and it was changed to a single 15-meter spillway. The maximum flow velocity is 31.2 meters/second.

3. The underground plant building is 40 meters upstream from the dam in the reservoir region. The span of the main plant building chamber is 21.5 meters (height 51.9 meters and length 105.6 meters). It is the second large underground plant building following only Lubuge Power Station in a hydropower project built in stratified rock in a limestone region in China. Shotcrete permanent supports, rock bolt crane beams (with bolts 8 meters long), and steel-fiber reinforced silicon powder shotcrete are used for the main and auxiliary plant buildings, the main transformer room, and so on. The bolts are 5- to 7-meter long full-bonding sand grout bolts. The four main construction support tunnels are used for permanent plant building drainage, ventilation, and pressure regulation chamber volume. There are few of these in China. The Dongfeng underground plant buildings have attained new levels in excavation, shotcreting, and leak prevention technologies.

4. The curtain grouting leak prevention system is the largest in scale in China at the present time. The total driving footage of the curtain grouting is 320,900 meters and it is configured in three-level galleries. The total length of the grouting galleries is 8.4 kilometers. The upper-level gallery is longest at 3.66 kilometers and is made of shotcrete with a poured concrete baseplate. The middle and lower-level galleries are both 0.4 meters in cross-section with a steel-reinforced concrete lining. They have a single drainage hole and two drainage holes. The usual hole depth is 65 meters and the hole depth in the riverbed section is 120 meters. On-site grouting experiments are now in progress, and we are doing stability and groutability experiments using powdered coal ash mixed in with the grouting liquid.

III. Construction Technologies and Construction Organization

Design reinspection, optimization, and consulting work provided favorable conditions for building the Dongfeng Hydropower Station project. Strict technical requirements and high engineering quality requirements posed some difficulties for construction, so we had to adopt new techniques, new technologies, and the corresponding technical equipment and construction management to meet the requirements. These are manifested mainly in these areas:

1. Controlled blasting technologies (smooth blasting, pre-cracking, and differential blasting) were used to excavate both the above-ground and underground chambers. The maximum height of the spillway side slope is about 100 meters and the rock above an elevation of 960 meters is rather poor. Vertical side slope excavation was used for the side slope along with shotcrete support and water drain hole measures. Punch bolts were used to reinforce the poorer rock strata sections. Pre-cracking blasting was used in excavation for the dam abutment and single blasting excavation that did not leave a protection layer was used for the bottom surface of the structure. Upstream from the dam abutment is a vertical side slope and the downstream side slope is 1:0.15. There is a terrace every 10 meters and no undercutting was permitted. The longitudinal velocity in sound wave tests of the bedrock on the bottom surface of the foundation was generally 4,500 meters/second. Smooth blasting was used for the main chamber of the underground plant building. Blast seismic effects were monitored and original measures were made of the deformation stress stability of the surrounding rock.

2. Shotcrete technologies were widely used for construction and permanent support. Silicon added to steel fiber shotcrete and system bolts were used in all the main and auxiliary plant buildings of the underground plant building, the main transformer room, and other main chambers. The total number of system bolts was about 21,000 and the amount of shotcrete was 9,000 cubic meters. Shotcrete support was used for the upstream and downstream faces of the dam abutment (10 cm of shotcrete and 3 to 5 meter bolts). Shotcrete support was also used for the high side slopes of the spillway. To further improve the quality of the shotcrete, construction units and the relevant institutions of higher education cooperated in doing on-site experiments with new techniques and mixing ratios and large-scale laboratory orthogonal experiments. Rather good achievements have now been made in reducing resilience and dust content, conserving cement use, and other areas. New advances have been made in the areas of shotcrete layer blast shock resistance, leak prevention, and strength.

3. To ensure the quality of concrete engineering for the dam body, extensive research and experiments were conducted on raw materials, mixing ratios, crack resistance properties, and other things in conjunction with state attacks on key S&T problems during the Seventh

5-Year Plan, and the achievements were applied directly in achieving real benefits in the Dongfeng project. "Mixed materials, dual sifting, and continuous air cooling" techniques which were part of special topical research on "matching mechanization for rapid construction of tall concrete dams" were adopted in the design and directly applied in the concrete system. These techniques were also used at Wuqiangxi and Ertan Hydropower Stations now under construction.

4. Developments in concrete quality control and advanced control and inspection and testing technologies. This was the first use in China of rapid determination of concrete strength and sand water content, and the use of surface wavemeters to measure the quality of hardened concrete. Computer technologies combined with engineering quality data tracking, feedback, and real-time analysis were used to forecast and control concrete quality. Sand and stone material data collection and concrete pouring and cooling quality management databases were established. Data was collected for use in quality control, evaluation, and forecasting to attain optimum temperature control results as scheduled and improve the crack-resistance properties of the concrete.

5. The large-scale curtain grouting leak prevention system uses underground divide crests as leak prevention lines and the bottom limit of the curtain was a relatively water-resistant strata. The grouting galleries pierced complex rock strata and karst subterranean stream channels. Nine levels of beach rock strata collapsed blocks and zones of karst cave development were revealed during excavation of the galleries. Because of restrictions by the terrain, there were relatively few construction support tunnels, with just one construction support tunnel per gallery. Each construction support tunnel controlled a gallery construction work face of about 1.6 kilometers, which made air, water, and power supplies, ventilation, and grouting liquid transport during construction rather difficult. About 50 grouting machines (dual machines and dual pumps) were in operation during the peak grouting period and the monthly progress rate for each machine was about 250 meters. The average monthly grouting progress rate was 10,000 meters. The curtain grouting project and large dam project will directly affect the power station's power generation schedule and they are the key projects which will control water storage and power generation at the large dam (280,000 meters of grouting will be necessary for power generation by the first generator). On the basis of applying experiences in grouting limestone karst strata from Wujiangdu Hydropower Station, the grouting technical equipment, grouting liquid, and construction deployments were improved further to facilitate completion of the predetermined tasks.

6. Strict temperature control requirements were formulated to ensure the quality of the concrete in the high, thin dam at Dongfeng. On the basis of engineering experience at Dong Jiang Hydropower Station and other places in China, it was extremely important that shortened rest periods, steady hoisting, and strict insulating and refrigeration techniques be adopted. The large dam mixing and refrigeration capacity was 4.685 million kcal/hour (1 cal $\approx$ 4.19 J). The temperature at the machine outlet was 10.7°C and the monthly hoisting elevation for the dam body concrete was 5.1 to 6.4 meters. Two 2 x 3 mixing buildings supplied the concrete for pouring. Delayed minimum swelling concrete with magnesium oxide mixed on the outside was used for the deep trench for the dam foundation. By eliminating conventional temperature control and one-period cooling, the pace of deep trench concrete pouring can be accelerated.

7. Because of the steep terrain and complex geological conditions in the dam region, concentrated structures, and narrow construction work site, configuring construction and communications was quite difficult. Both banks below the elevation of the dam crest are steep rock walls and the top of the dam was accessible only by highways to the dam crest. Only a single highway at an elevation of 840 meters could be built in the riverbed running to the base pit, which made it very hard to remove debris excavated from the dam pit and dam abutment and move in equipment. Debris smoothing shaft sinking methods were used in the original design for excavation for the dam abutments on both banks. Because the depth of inlaying was reduced after design optimization, construction work faces for each step were narrow and it was difficult to meet construction strength requirements. After repeated research, this was changed to a riverbed debris removal program. The concentrated deployment of structures caused mutual interference at the construction site and placed greater restrictions on the construction schedule. Three-dimensional construction meant that construction positions at each elevation had to be completed in very tight time segments. Excavation of the left bank anchoring tunnel and cable machine machine room, excavation of the flood drainage intake and outlet and reinforcement processing, and construction of the first part of the left dam top and spillway were done in an adjacent work area. Construction of the cable machine platform, above the right dam crest, the locomotive passageway, and the 978 mixing system were interlinked and involved substantial excavation. The effects of linked progress rates in the construction schedule brought changes to construction procedures and methods. In the initial design, it was originally decided that after the diversion closure, construction of the four weirs (the upstream and downstream earthen weirs, the upstream and downstream concrete arch weirs, and the gravity concrete weir) should be completed, that the deep trench should be excavated, and the concrete should be poured on the river water surface during the first dry season. On the basis of the actual construction situation, the work to be done during a single dry season was changed to completing it during two dry seasons. Before the diversion closure, because of fund problems and leaks in the flow diversion tunnel, the diversion closure time was delayed to 30 January 1989, but excavation for the dam abutment was not completed at that time. Regardless of whether the debris smoothing or riverbed

debris removal program was adopted for dam abutment excavation, it was hard to prevent a large amount of stone debris from falling into the river during excavation and construction. Blocking the river channel and banking up to the original riverbed water level caused problems for diversion closure and weir construction. For this reason, after diversion closure for Dongfeng Hydropower Station, construction of three weirs had to be completed and flood transit requirements had to be met. Excavation of the deep trench and pouring of the concrete in the deep trench were done during the second dry season (1989-1990) to ensuring pouring of the concrete for the dam body in 1990.

Construction of the Dongfeng Hydropower Station began in November 1984. Some 45 million yuan was invested form 1984 to 1986, and construction preparations as well as part of the pre-construction project were completed. Another 66 million yuan was invested in 1987 and they completed the construction auxiliary enterprise and excavation of the construction support tunnel and flow diversion tunnel to ensure that conditions were ready for diversion closure in 1988. Another 100 million yuan was invested in 1988 for full excavation of the flow diversion tunnel, construction of the lining, and installation of the lock gates done in conjunction with excavation to clear the dam abutments on both sides and the spillway, construction of the sand and rock mixing system, excavation for the cable machine platform and locomotive passageway, and so on. Because a large amount of water surges occurred in the flow diversion tunnel in 1988 and insufficient construction equipment delayed progress, diversion closure was not achieved until 30 January 1980. Construction of the base pit, excavation of that portion of the dam base below 845 meters, and pouring of the concrete for the deep trench for the power station is now in progress. Pouring of the concrete on top of the deep trench at an elevation of 825 meters was done in April 1990.

To ensure that construction of the power station proceeds safely and smoothly, the units responsible for construction have entrusted Huayuan Consulting Company with long-term technical consulting.

Technical Indicators for Concrete Used in the Dongfeng Arch Dam

Sequence number	Location of concrete	Strength grade	Ultimate tensile value (28d) x 10^4	Leak resistance grade (28d)	Freezing resistance grade	Ultimate water/ash ratio	Strength assurance rate (percent)	Coefficient of dispersion
1	Slopes, trench fill	$R_{90}300$	0.90	$> S_8$	D_{50}	≤ 0.50	90	≤ 0.15
2	Dam body region A	$R_{90}300$	0.90	$> S_8$	D_{50}	≤ 0.50	90	≤ 0.15
3	Dam body region B	$R_{90}250$	0.85	$> S_8$	D_{50}	≤ 0.55	85	≤ 0.15
4	Surface of spillway holes	R_8400	0.95	$> S_8$	D_{50}	≤ 0.50	90	≤ 0.13
5	Cantilever pre-anchoring	$R_{28}400$	1.00		D_{50}	≤ 0.50	90	≤ 0.10

Construction Moving Smoothly on First Stage of Ertan

906B0082A Chengdu SICHUAN RIBAO [SICHUAN DAILY] in Chinese 26 Apr 90 p 1

[Article by Zhao Jian [6392 1017], Nie Zeheng [5119 34419 1854], and Xian Rong [7639 2837]: "Largest Hydroelectric Power Project Ever Built in China, Ertan Hydroelectric Station Proceeds Smoothly in Its First-Stage Construction"]

[Excerpts] SICHUAN RIBAO—Work on the largest hydroelectric power station ever built in China, the Ertan station, is proceeding rapidly in its first stage. The builders of this international competitive bidding project arranged for satisfactory construction conditions for international engineering contractors: 46 items of first-stage engineering subprojects were basically completed, with the investment of 320 million yuan already spent. As expressed by General Manager Sun Zhongbi [1327 0022 1732] of the Chinese Ertan Hydroelectric Development Corporation, conditions are ripe for international contractors to take over in building the Ertan Hydroelectric Station, vigorously supported by the state, Sichuan Province, and Panzhihua Municipality.

At the Ertan Hydroelectric Station (over the Yalong Jiang) 40 kilometers from Panzhihua Municipality, the design dam height is 240 meters; the total installed capacity is 3.3 million kW; and the annual power generation is expected to be 17 billion kWh, to rank first in China. Today, 240-ton flat-bed tractors can negotiate the Tongzilin suspension bridge (capable of sustaining the heaviest loading in China) built by the Second Bureau, Ministry of Railroads, and the Santan Highway Bridge built by the Panzhihua Municipal Construction Corporation. The highway along the right bank of the Yalong Jiang has been paved. On the recently built highway on

the left bank, a concrete road surface is being poured. At the construction site, the highway is being rapidly paved. In addition to the bridges and roads, work is also progressing smoothly on such subprojects as power facilities, temporary housing, debris dumps, communications, and improved fuel dumps. In addition, the Chinese builders are taking the initiative to be responsible for some of the 13 main construction items including excavation of the intake tunnel. [passage omitted]

Rows of two-story residential buildings reserved for foreign experts are nearing completion and sites reserved for housing of the international contractors have been allocated. Residential facilities, such as satellite television facilities and swimming pools, are nearing completion. [passage omitted]

Work Stepped Up on Tongjiezi

906B0082B Chengdu SICHUAN RIBAO [SICHUAN DAILY] in Chinese 6 May 90 p 1

[Article by Huang Yongsheng [7806 3057 4141]: "Relying on New Technology To Overcome Construction Difficulties, Tongjiezi Power Station Speeds Up Construction Pace"]

[Excerpt] SICHUAN RIBAO—As a key construction project in the state's Seventh 5-Year Plan, the Tongjiezi hydroelectric power station embodies new technology in its construction, to solve difficult technical problems due to complicated strata and rock formations and to speed up the pace of construction. At present, two-thirds of the concrete at the dam has been poured and three enclosures for the water turbine generators have been poured.

Construction of this big hydropower station began on 23 January 1985. The generators are rated at 600,000 kW with an expected annual power generation of 3.2 billion kWh. [passage omitted]

Sichuan Building Eight Medium-Sized Hydropower Stations

906B0082C Chengdu SICHUAN RIBAO [SICHUAN DAILY] in Chinese 25 Apr 90 p 2

[Article by reporters Guo Jiaren [6753 0857 0088] and Zou Huan [6760 4883]: "Speeding Up Construction Pace of Power Generation Facilities, Sichuan Province Is Building Eight Intermediate Sized Hydropower Stations"]

[Text] SICHUAN RIBAO—The hydropower departments of Sichuan Province are building eight medium-sized hydropower stations with a total installed capacity of 270,000 kW. These hydropower stations have features of short construction periods, low investment, and high economic return. There are a total of 65 rivers in Sichuan Province capable of accommodating medium-sized hydropower stations with a potential installed capacity of 14.9 million kW, representing 22 percent of potential medium-sized hydropower station resources in China. Nine medium-sized hydropower stations (including Dahong He and Caopo) with a total installed capacity of 755,500 KW have been completed in Sichuan Province. Today, eight medium-sized power stations are under construction: Mahui, Jiangkou, Anju, Luosichi, Sijiutan, Ganbao, Wenfeng, and Weituo. These eight power stations account for one-third of China's medium-sized power stations now under construction.

Developing the Hydropower Resources of the Heilong Jiang

906B0111A Zhengzhou KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 21 Aug 90 p 1

[Article by reporter Zhang Ling [4545 0407]: "An Investigative Report on Heilong Jiang Hydropower Resources"]

[Excerpts] The Heilong Jiang is China's third largest river, well-known for its vast drainage area which is comparable to that of the Chang Jiang, and for its abundant water flow—seven times greater than that of the Huang He.

This July this reporter accompanied the party of Heilongjiang's Governor Shao Qihui on a 3,000 km trip, making a field study of Heilong Jiang hydropower resources.

As the Heilong Jiang's source, the Argun River originates in the Mongolian People's Republic; its northern source is the Shilka River in the USSR. The total drainage area of the Heilong Jiang Basin is 1,843,000 square kilometers, covering part of China, the USSR, and Mongolia. The drainage area within Chinese territory covers 900,000 square kilometers. Its overall length is 4,300 kilometers. [passage omitted]

As related by experts in the party, the natural drop of the river is more than 270 meters along the Heilong Jiang's mainstream. The hydropower reserve is 8.6 to 10 million kW, of which 4.2 million kW is in Chinese territory, accounting for 60 percent of exploitable hydropower resources in Heilongjiang Province.

As early as the 1950's, China and the USSR conducted a joint survey of the Heilong Jiang. Both governments signed the Agreement for the Joint Exploration and Scientific Study of Natural Resources and Development Prospects of the Amur Drainage Area, and Prospective Design With Full Utilization of the Upper Reaches of the Argun River and the Amur. In addition, in first-stage planning, an installed capacity of 8 million kW of power units (with an annual power generation of 27 billion kWh) was envisioned. This power generation can replace approximately 8 million tons of standard coal used for thermal power generation.

After three decades, unfortunately the water still freely flows eastward without serving any useful purposes. Look at the map: the banks of the Amur in its middle and

upper reaches are not barren land. Along the right bank of the river that lies within Chinese territory, there are four administrative units [two prefectures and two municipalities]: Da Hinggan Ling, Heibe, Yichun, and Jiamusi, 11 counties, 12 state-operated farms, 5 forestry bureaus, 22 timber tracts, 600,000 inhabitants, and 6 million mu of cultivated land.

In the investigation trip, the party covered 3 prefectures, 6 counties, 5 forestry bureaus (tracts), and 14 xiang (townships) and villages along the Amur. There, dense forests cover the land accounting for one-eighth of China's total timber reserve. The gold reserve ranks third in China regionally; of this reserve, the placer gold reserve ranks first in size nationally. Copper reserves rank eighth in the nation.... Due to power shortages, however, about 30 percent of production capacity is not exploited, thus restraining economic development in the border zone.

On this point, Governor Shao Qihui expressed his profound regret. When he received this reporter's interview of the river trip, he said that this kind of distortion of exploitation and utilization of hydropower resources was found elsewhere as well as in Heilongjiang Province; this province does have a weak link that restrains economic development because of the irrational structure of energy sources. With the overall power generation capacity in the province at 5,850,000 kW, 3 percent of this comes from hydropower units, a bare 162,100 kW. Generally, about 25 percent of the power from hydropower generation for adjustment of peak power load is the rational proportion. However, in Heilongjiang Province, only 3 percent of the total load comes from hydropower for adjusting the peak load; thus, there are severe power shortages in the province. Although quite a few power plants were built in recent years, power generation is still restrained by coal output and transportation bottlenecks. These shortcomings force the province's energy policy to stress hydropower and steam power simultaneously. Actually, provincial hydropower resources are not low with a theoretical hydropower reserve of 7,430,000 kW, accounting for 49.1 percent of the total hydropower reserves of Liaoning, Jilin, Heilongjiang (the three northeast provinces) and Inner Mongolia (including its three leagues and one municipality). Heilongjiang Province has 270 sites of exploitable hydropower resources where at least a 500 kW power unit can be installed, for a total potential capacity of 6,091,900 kW. As of the end of 1989, however, installed hydropower capacity was only 2.66 percent of provincial exploitable hydropower resources; 97.34 percent of the hydropower resources just flows out untapped. Energy sources are the foundation of economic construction and development; the comprehensive exploitation and utilization of Heilongjiang is urgent. There is a need for a development strategy. In addition to stressing the province's hydropower, attention should also be given to water conservancy, transportation, fisheries, and ecology and environmental protection. A comprehensive systematic study should be made of agriculture, forestry, gold mining and border trade in the province.

Heilongjiang has awakened. The exploratory and prospecting work has been completed for the second Sino-Soviet joint exploration of Heilongjiang's water resources for comprehensive utilization. A planning and design stage is just around the corner.

After three decades of neglect, exploitation and utilization of hydropower resources in the province will begin from a zero basis. At about the same time that the governor's party was exploring the Heilong Jiang, general manager Yao Zhenyan [1202 2182 3508] of the State Energy Investment General Corporation and his party spent 6 days in an intense study of the mainstream of Mudan River. On 15 August, when both parties returned to Harbin, the Heilongjiang Provincial Government signed an agreement with the State Energy Investment General Corporation to build the Lianhuapao hydropower station on the Mudan River as a priority project in the Eighth 5-Year Plan. The station is designed for an installed capacity of 550,000 kW, with an annual power generation of 740 million kWh.

East China Grid To Add Big Pumped-Storage Station

906B0111B Shanghai JIEFANG RIBAO in Chinese 20 Jun 90 p 3

[Article by Wang Junguo [3076 0193 0948]: "A Large Pumped-Storage Power Station Will Be Built in East China"]

[Text] Anji—The first large pumped-storage power station of the East China power grid will be built at Tianhuang Ping in Anji County. The installed capacity of this power station is 1.8 million kW, which is 50 percent larger than Shanghai's largest power facility at Yangshupu. The pumped-storage station can provide 3.6 million kW to the power grid. The station will be situated on the northern slope of the Tianmu Mountains in northwestern Zhejiang Province. The site is close to the center of the power load with reliable water sources; the average water level difference is 566 meters. Investments in the station will come jointly from three provinces and one municipality: Jiangsu, Zhejiang, Anhui, and Shanghai. After the power station is completed, the annual power generation will reach 3.16 billion kWh.

With the rapid economic growth in East China and the steady increases in residential power consumption, peak and valley differences in the power load are mounting. At a pumped-storage power station, residual power at low load is utilized to pump water into a reservoir in the upper reaches to generate power at peak loads, thus raising the peak regulating capability and peak power supply capacity of the grid. This power station will adjust the power load on a daily basis for missions of peak load adjustment, residual power utilization at low load, phase and frequency adjustment as well as power reserve for emergencies in the East China Grid.

State Council Approves 16 Projects With Total Capacity of 5.9 Million Kilowatts

906B0090B Beijing RENMIN RIBAO in Chinese 4 Jun 90 p 1

[Article by reporters Zhao Mingliang [6392 2494 0081] and Wang Xianguang [3769 7359 0342]: "State Council Approves Another 16 Electric Power Projects, Total Investment 9.3 Billion Yuan, Installed Generating Capacity 5,900 MW"]

[Text] People in the State Energy Resource Investment Company stated that the State Council recently approved the start of construction of another 16 large and medium-sized electric power projects.

The State Council has formally issued large and medium-sized electric power capital construction project construction start documents for 1990. These 16 projects are: Heze Power Plant in Shandong, Zhengzhou Heat and Power Cogeneration Plant in Henan, the first phase project at Qinhuangdao Power Plant in Hebei, Shuangliao Power Plant in Jilin, the fourth phase project at Huaibei Power Plant in Anhui, Zunyi Power Plant in Guizhou, Tieling Power Plant in Liaoning, Zhu Jiang [Pearl River] Power Plant in Guangdong, Yangluo Power Plant in Hubei, Beijing No 3 Heat and Power Cogeneration Plant, Chentangzhuang Heat and Power Cogeneration Plant in Tianjin, Datong No 1 Heat and Power Cogeneration Plant in Shanxi, Changxing Power Plant in Zhejiang, Wuhu Power Plant in Anhui, Pingdingshan Heat and Power Cogeneration Plant in Henan, and the second phase project at Shajiao A Power Plant in Guangdong.

Information indicates that these 16 electric power projects will involve total investments of 9.3 billion yuan and will increase the installed electric power generating capacity by 5,900 MW after going into operation. Plans for 1990 call for 1.2 billion yuan to be invested, mainly for civil engineering.

Among the construction start projects, besides two projects to substitute coal for oil, state investments will account for one-third of the total scale of investments and will fully play the guiding role of state investments. State investments will be used to attract local revenues to develop the basic energy resource industry. Seven of the projects are being built entirely through local investments. They will have an installed generating capacity of 1,400 MW at an investment scale of nearly 2.2 billion yuan.

Half of these electric power projects involve expansion on the basis of existing power plants, which can conserve investments, shorten construction schedules, and permit earlier power generation. Five of the new construction projects are heat and power cogeneration plants which can supply electricity and provide centralized heat supplies. This can also improve environmental, heat supply, and heating conditions and conserve fuel resources.

1200 MW Shidongkou Plant Completed

906B0090A Shanghai WEN HUI BAO in Chinese 30 May 90 p 1

[Article by reporters Yang Ying [2799 5391] and Lu Yongfeng [4151 3057 6912]: "Shidongkou Power Plant Fully Completed, Shanghai's Biggest Power Plant, Total Installed Generating Capacity 1,200 MW, Completion Increases Shanghai's Installed Power Generation Capacity by Almost 30 Percent"]

[Text] Shanghai's biggest thermal power plant, Shidongkou Power Plant with four 300 MW generators, is now fully completed. Completion of this power plant, which has a total installed generating capacity of 1,200 MW, has increased Shanghai's installed power generation capacity by almost 30 percent. This was announced at an on-site press conference held at Shidongkou Power Plant by the Shanghai Municipality Major Project Construction Office and Shanghai Municipality Electric Power Bureau on 29 May 1990.

Shidongkou Power Plant was a key national construction project. This is the first time that China produced the equipment for the four 300 MW steam turbine generators installed there. Construction of this project is the first time that China has adopted the method of planning and building four generators at the same time and placing them into operation in sequence. This substantially shortened the construction schedule and achieved the goals of conserving investments and good results. Through the arduous efforts of over 50 construction staffs with more than 10,000 builders from Shanghai and fraternal provinces and municipalities, it took just 57 months to completely finish this project after groundbreaking to begin construction on 27 July 1985, more than 10 months ahead of schedule requirements in state plans. Shidongkou Power Plant has already generated 7.8 billion kWh of power since the first 300 MW generator was connected to the grid and began generating power at the end of 1987.

It took less than 4 years to place generators with a total installed generating capacity of 1,200 MW into operation. This was the first time in Shanghai Municipality since liberation, and it was the first time that stable and full output has supplied so much power to Shanghai in such a short time. Completion of Shidongkou Power Plant is playing a big role in reducing Shanghai's power shortage and promoting growth of industrial production. Shidongkou Power Plant has now become Shanghai's energy resource base area. Its power output now accounts for about one-third of total power output in the Shanghai region.

Development of Shanghai's electric power industry has leapt up to a new stage in the past few years. It was revealed that Shanghai will continue building several large electric power projects during 1990, including the expansion project at Wujing Heat and Power Cogeneration Plant involving two 300 MW generators, the 500 kV Yanggao Transformer Station, two 600 MW generators

at Shidongkou No 2 Power Plant, several 220 kV and 110 kV power transformation projects, and so on. The power transformation capacity at all grades planned for startup in 1990 is 2.36 million kVA.

Installation Work Begins at Changshu

906B0090C Shanghai JIEFANG RIBAO in Chinese 20 May 90 p 3

[Article by Liu Zhuhua [0491 4376 5478]: "Changshu Power Plant Goes Into Construction, One of 20 Key State Projects, First Phase Project Completion Planned for 1995, Yearly Power Output To Be 6.6 Billion kWh"]

[Text] One of 20 key state construction projects, Changshu Power Plant, has now gone into construction. The planned scale of the construction project is a capacity of 2,400 MW with installation of four 300 MW generators and two 600 MW generators. The installed generating capacity of the first phase of the project is 1,200 MW involving installation of four 300 MW generators at a project construction cost of 1.9 billion yuan (including matching projects). Plans call for full completion of the first phase project in 1995. It will generate 6.6 billion kWh of power annually, which is equivalent to 1.5 times China's total power output shortly after liberation. Construction of Changshu Power Plant is of extremely great significance for promoting rapid economic development in the east China and Jiangsu region and completing the state's Eighth 5-Year Plan.

To achieve safe, high quality, and rapid completion of the power plant, the Changshu Power Plant construction project adopted comprehensive bid solicitation for design, construction, and equipment ordering for the first time in the history of electric power construction in China.

Changshu Power Plant will adopt several new Chinese technologies, techniques, and equipment as well as advanced foreign imported technologies. A 35,000-ton pier will be built for the power plant's coal transport system. Two bridge coal drops with a coal unloading capacity of 1,250 tons/hour will be installed on the pier. The power plant's control system will have computer control and computer and simulation regulation. The control and protection devices and equipment will be jointly composed of automated systems.

Construction of Changshu Power Plant has received close attention from the CPC Central Committee and State Council. It was included among 20 key state construction projects in November 1989. Premier Li Peng also wrote the plant name for "Changshu Power Plant." Preparatory work for the Changshu Power Plant construction project is now fully under way. Three openings and one leveling work are basically finished in the plant region and the 35 kV construction power transformer station, 35 kV lines, and 10 kV lines have been turned over for use. The highway outside the plant and the construction roadway in the plant area have been put into place and turned over for use. Almost 200,000 square meters of land has been leveled in the area of the plant and the main plant buildings. At the site, 23,000 cubic meters of foundation engineering for the main plant buildings has been prepared and more than 1,150 piles have been driven.

Jiangyou Plant Expansion Project Update

906B0092A Chengdu SICHUAN RIBAO in Chinese 14 Jun 90 p 1

[Article by Wu Mingyuan [0702 2494 0337] and Wang Shihe [3769 0013 0735]: "Jiangyou Power Plant Expansion Project, First Generator Debugging Speeded Up, Will Connect to Grid and Generate Power Soon, Entire Project Has Completed Nearly 70 Percent of Investments"]

[Text] Since ground was broken on 1 October 1987 to begin construction of a key state project during the Seventh 5-Year Plan, the Jiangyou Power Plant expansion project, nearly 4,000 builders have been struggling hard and working painstakingly. The boiler of the first generator was ignited and given an acid bath and electric-powered barring of the steam turbine generator was completed in mid-May 1990. High-pressure steam pipe flushing is now in progress and it has entered an intense debugging stage. It will be connected to the grid and generate power soon.

This project is a large thermal power generation project built through joint investments by Sichuan Province and the Ministry of Energy Resources. Two complete 330 MW generators imported from France will generate 5.85 billion kWh of power annually. The total project investment is 1.1 billion yuan and 68.7 percent of the total investment has now been completed. Project construction implemented a new management system of overall contractual responsibility focused on design. Because it fostered design advantages, when supplies of matching materials for the design supplied by France failed to keep up with the pace of progress arranged in the Chinese design, convention was broken and an integrated Chinese-foreign method was adopted to prepare the main plant building foundation blueprints by volume and group to enable groundbreaking for construction of the project's main plant building 8 months ahead of schedule. The Sichuan Provincial First Electric Power Construction Company overcame construction problems from high groundwater levels and the rainy season. Undaunted by bitter cold and intense summer heat, they fought night and day. The pouring of the frame structure for the main plant building they constructed was acknowledged by the Ministry of Energy Resources Key Project Quality Inspection Group as "one of the best projects in China." Earthworks construction of the entire project is now basically complete. According to quality evaluation grade statistics for 2,100 items that have been completed, inspected, and accepted, the rate of excellence was 80 percent. The Northeast China First Power Construction Company is installing the equipment as it arrives. The stator of the generator was lifted into

position by crane on the day it arrived at the site and the steam turbine generator installation tasks were completed ahead of schedule. During project construction, all units involved in construction cooperated closely with French experts, which accelerated the pace of construction at the Jiangyou power plant project. During the time of turmoil in 1989, none of the French experts at the construction site returned to France and they did not miss a single day of work.

After the Jiangyou Power Plant expansion project goes into operation, it will greatly reduce Sichuan's electric power shortage and play an important role in invigorating Sichuan's economy.

Work Accelerated on Five Big Coal-Fired Power Bases

906B0092B Beijing JINGJI RIBAO in Chinese 19 Jun 90 p 2

[Article by reporter Zhang Shiqing [1728 0013 1987]: "Development and Construction Accelerated at Five Big Coal-Fired Power Base Areas in Inner Mongolia"]

[Text] Five new flickering stars have appeared on the vast Inner Mongolia grasslands. They are the five simultaneous projects in Inner Mongolia centered on the four large famous Huolin He, Jungar, Yuanbao Shan, and Yimin He open-cut coal mines and huge Dongsheng Coal Field. According to data supplied by statistical departments, 4.5 billion yuan of investments had already been completed in building these five large coal base areas by the end of 1989 to form an installed generating capacity of 1,700 MW and an annual raw coal production capacity of more than 4 million tons. By the end of 1995, raw coal output will increase 8.2 times and power generation capacity will increase 1.9 times over present levels to reach 37 million tons and 5,042 MW, respectively.

The four big strip mines in Inner Mongolia are key state development projects for the Seventh 5-Year Plan. Dongsheng Coal Field covers an area of 10,000 square kilometers. It is one of the world's few huge superior quality power coal fields. These five big coal fields have proven reserves of 118.14 billion tons, equal to one-seventh of China's total proven reserves. On the basis of the rich geological reserves and abundant water resources of these five big coal fields and the real situation of railway transport shortages, the state has decided to convert primary energy resources to secondary energy resources locally by simultaneously developing coal fields and building pit-mouth power plants and accelerating construction of five big coal/power base areas at Huolin He Strip Mine-Tongliao Power Plant, Jungar Strip Mine-Fengzhen Power Plant, Yuanbao Shan Strip Mine-Yuanbao Shan Pit-Mouth Power Plant, Yimin He Strip Mine-Yimin He Pit-Mouth Power Plant, and Dongsheng Coal Field-Dalad Power Plant. Among them, the state has included Huolin He Strip Mine-Tongliao Power Plant and Jungar Strip Mine-Fengzhen Power Plant among key energy resource construction projects for 1990. It has decided to invest 7.409 billion yuan in these two base areas, and 2.13 billion yuan in investments have already been completed to form a yearly raw coal output capacity of 3 million tons and an installed power generating capacity of 800 MW. Within the next 3 years, the raw coal production capacity may reach 23 million tons and the installed power generating capacity may surpass 1,400 MW.

Yuanbao Shan Strip Mine and Yuanbao Shan Pit-Mouth Power Plant are "sisters." For various reasons, the synchronized projects cannot be built simultaneously. Two generators totaling 900 MW have already gone into operation but the strip mine has not yet formed a corresponding production capacity. Recently, because of the serious power shortage in Liaoning Province, the State Energy Resource Investment Company, Liaoning Province, Shenyang City, and Chifeng City raised 2.51 billion yuan in capital to expand the power plant. The two new 600 MW generators have the largest single-unit generating capacity in China at the present time. The total power generation capacity at Yuanbao Shan Power Plant will reach 2,100 MW. To achieve the required balance between coal supply and demand, the state has speeded up expansion of nearby Pingzhuang Coal Mine and decided to invest 765 million yuan, including 95 million to be allocated during 1990, to accelerate construction of Yuanbao Shan Strip Mine, which has a yearly production capacity of 5 million tons. In addition, 870 million yuan in investments have been completed at two coal/power base areas, Yimin He Strip Mine-Yimin He Power Plant and Dongsheng Coal Field-Dalad Power Plant. Coal output may reach 12 million tons and the installed generating capacity will be 1,100 MW during the later part of the Eighth 5-Year Plan.

According to statistics from the Inner Mongolia Autonomous Region Planning Commission concerning the balance between coal supply and demand, yearly raw coal output from these five large coal/power base areas may reach 73 million tons and the installed generating capacity will be 8,700 MW by the end of this century. Inner Mongolia's total yearly raw coal output will surpass 120 million tons and its installed generating capacity will be 10,620 MW. It will also ship out 50 million tons of coal to other areas and support northeast and north China with 26 billion kWh of power.

Installation Work in Progress on Huaneng Yueyang Plant

906B0092C Beijing JINGJI RIBAO in Chinese 19 Jun 90 p 2

[Article by reporter Xu Dehuo [1776 1795 3499]: "Huaneng Yueyang Power Plant Now Entering Decisive Installation Phase"]

[Text] At Huaneng Yueyang Power Plant, a key state project, 90 percent of the earthworks construction tasks have been completed and installation of equipment for

seven large systems for water, coal, steam, oil, power transmission, power reception, and dust and ash removal is now fully under way. A huge army of 5,000 builders is fighting day and night toward the goal of generating power by the end of 1990.

Huaneng Yueyang Power Plant, located at Chengyingji where Dongting Hu runs into the Chang Jiang, is the first thermal power project China is building using loans from the government of England. All the equipment and technologies are imported from England. Huaneng International Electric Power Development Company and Hunan Province have jointly invested 1.8 billion in construction. It has two 360 MW generators which will generate 4.2 billion kWh of power annually. After it goes into operation, it will increase the value of industrial output by more than 10 billion yuan and it will play an important role in changing the loss of proportion between hydropower and thermal power in Hunan.

The 5,000 cadres and workers from the China Fifth Construction Bureau's Yueyang Power Plant Contracting Company, Northwest China First Power Construction Company, and Shanghai Foundation Company participating in construction of this project have united to face constant wind and rain from the time ground was broken on 13 August 1988 until now and have pushed forward with the project quickly. Because of delays in the blueprints, materials, and so on supplied by England, the earthworks engineering was delayed and there was no way that installation work could get under way fully. To remove this obstruction, Huaneng Yueyang Power Plant pressed forward from 25 March to 25 April 1990 and won a brilliant victory. The dual water drainage open channel project built by 120 employees in this bureau's First Company was a project which risked hazards to prevent flooding during a period of rising water. It is 64 meters long and contains 259 tons of steel reinforced ties and 513 cubic meters of poured concrete. To save time, workers jumped into the muddy water and worked for over 10 hours at a stretch. They finished a task in 19 days that it normally takes 2 months to complete. The more than 3,000 employees of the China Fifth Construction Bureau fought a bitter battle for 33 days. Most of the tail-end projects have been wrapped up. These included 28 projects completed on schedule and four projects delayed for external reasons. The installation work is now fully under way.

Unity and cooperation are the forces which accelerate project progress. In February 1990, it appeared that holes for the steel pipe piles at the coal pier built by Shanghai Foundation Company would not be raised to the water surface before the flood season on the Chang Jiang arrived. The Hunan Province Highway and Bridge Company was notified and immediately transferred eight drill rigs to the site to aid the battle. This shortened the pile driving time by 20 days and avoided effects from flooding.

By mid-May 1990, 4,963 items of the 5,432 earthworks sub-projects which had completed inspection and acceptance conformed to superior quality standards, an excellence rate of 90.8 percent. This is uncommon in large earthworks projects.

3.6 Million Kilowatt Plant for Shanghai

906B0081A Shanghai WEN HUI BAO in Chinese 5 May 90 p 1

[Article by Tian Li [3944 4539]: "State Planning Commission Formally Approves Construction of Pudong Waigaoqiao Power Plant"]

[Text] The State Planning Commission recently approved construction of Shanghai's Waigaoqiao Power Plant project, one of the main basic facilities projects to open up Pudong and develop Pudong.

The construction scale of this big thermal power plant was provisionally considered at 2,400 MW, with some room for expansion, but most recently the installed generating capacity was increased to 3,600 MW. Like the already completed Shidongkou Power Plant, the first phase project approved for construction this time will have an installed generating capacity of 1,200 MW with installation of our 300 MW coal-fired generators.

After the first phase of Waigaoqiao Power Plant project goes into operation, it will use about 3.2 million tons of coal annually to generate power. The State Planning Commission has made arrangements for this in agreeing that Shenfu and Dongsheng Mining Regions will supply superior quality power coal which will be transported on the Daqin [Datong-Qinhuangdao] Railroad to Qinhuangdao and then shipped by sea to the power plant's pier to guarantee power generation requirements at Waigaoqiao Power Plant.

The Shanghai Municipal Government, State Energy Resource Investment Company, and Shanghai Municipal Electric Power Industry Bureau are each responsible for raising a portion of the project investments required for Waigaoqiao Power Plant.

To begin as soon as possible at this basic facilities project that is a key part of the overall development strategy for Pudong, the Shanghai Municipal Electric Power Industry Bureau is now working feverishly on preparatory work for construction of Waigaoqiao Power Plant. To date, work for testing the foundation piles at the power plant and the related experiments have now basically been completed.

Work Progressing on Two Shentou Pit-Mouth Plants

906B0081B Beijing RENMIN RIBAO in Chinese 26 May 90 p 2

[Article by RENMIN RIBAO reporter Wang Aisheng [3769 5337 3932] and Xinhua Agency reporter Chi

Maohua [3069 5399 5363]: "Shentou Town To Become China's First Electric Power City, Two Pit-Mouth Power Plants Will Generate 13 Billion kWh of Power Annually"]

[Text] Shentou No 2 Power Plant, a large pit-mouth power plant with a total installed generating capacity of 2,200 MW, is now rising up at Shentou Town at the source of Sanggan He in Shanxi Province. Shentou Town, once wilderness, will become China's first electric power city.

On 18 May 1990, we arrived at the power plant construction site. We saw only tall smokestacks, vast plant buildings, tidy residences, and crisscrossing roads, some already completed and others nearing completion.

We were told that the power plant project is being carried out in two stages. The first phase of the project began in October 1988 and involves total investments of 1.49 billion yuan to install two imported 500 MW generators for an installed generating capacity of 1,000 MW. It will be completed and go into operation in October 1992. It will generate 6 billion kWh of power annually, 30 percent of which will be supplied to Beijing.

Shentou is located in Shuozhou, Shanxi Province. This area has abundant groundwater resources and a multitude of springs that form the "Shentou Sea." The minimum flow rate is 6 cubic meters/second. This is the source of Sanggan He. The area has 12.6 billion tons of coal reserves and is near the famous Pingshuo Antaibao Strip Mine developed jointly by China and the United States. Communications are convenient here and the Northern Tongpu [Datong-Mengyuan] Railroad and Dayun [Datong-Yuncheng] Highway pass through the area, as does the Shentou-Datong-Fangshan HV power transmission line, so it has excellent conditions for building a big pit-mouth power plant. Shentou No 1 Power Plant was completed and began operating in 1977. It has a total installed generating capacity of 1,350 MW. This plant is responsible for 40 percent of the power supplied to Shanxi Province. The state approved construction of a key state project, Shentou No 2 Power Plant, in October 1988. The planned total installed generating capacity of the second phase project for Shentou No 2 Power Plant is 1,200 MW. At that time, little Shentou Town will have two big pit-mouth power plants with a total installed generating capacity of 3,550 MW that will generate 13 billion kWh of power a year, half of the total amount of power generated in Shanxi Province, with an annual gross value of output of over 700 million yuan, making it China's biggest electric power city.

The powerful Shanxi Second Power Construction Company is responsible for building Shentou No 2 Power Plant. This company has received numerous provincial and ministry advanced enterprise commendations. During construction of the Shentou No 2 Power Plant, this company will face new topics and adopt new construction techniques, technologies, and methods to overcome many difficulties in construction and ensure high quality in construction engineering and a fast progress rate. It will also save a substantial amount of capital and materials for the state.

Party and state leaders Jiang Zemin, Li Peng, Li Ruihuan, Wan Li, and other comrades have been very concerned with construction of Shentou No 2 Power Plant. They have toured the construction site and met with construction workers. While he was paying a New Year call to workers at the Shentou No 2 Power Plant construction site on the eve of the 1990 Spring Festival, General Secretary Jiang Zemin said, "We certainly must build the 500 MW generators well!" The concern of leading comrades in the CPC Central Committee has given enormous encouragement to the builders of Shentou No 2 Power Plant.

Inner Mongolia Stresses Thermal Power Development

906B0081C Hohhot NEIMENGGU RIBAO in Chinese 2 May 90 p 4

[Article by NEIMENGGU RIBAO reporter Li Shuxiu [2621 3219 4423]: "Flourishing Development of Inner Mongolia's Electric Power Industry"]

[Text] The spring wind of the party's reform and opening up has drawn Inner Mongolia's electric power industry onto the path of healthy development, and implementation of "input/output" contractual responsibility has been like adding wings to a tiger, leading it to flourishing development. Looking toward the future and the long road ahead, Inner Mongolia's electric power industry must make noteworthy contributions to all aspects of economic construction in Inner Mongolia as well as north and northeast China.

Inner Mongolia originally was a region with an extremely weak electric power industry. Shortly after liberation, Inner Mongolia had just eight small thermal power plants with an installed generating capacity of only 13.4 MW. After more than 20 years of development, Inner Mongolia's total installed electric power generating capacity had not even reached 1,090 MW by 1978, far less than needed to meet the requirements of economic development and improvements in living standards in Inner Mongolia Autonomous Region.

The policy of reform and opening up brought an excellent wave of rapid development to Inner Mongolia's electric power industry. News of repeated victories flowed in from the electric power battlefront in the 1980's. The second phase project at Yuanbao Shan Power Plant and China's first 600 MW generator went into operation. Several medium-sized and small generators went into operation in succession from Hailar, Jalantun, and Tongliao in the east to Xilin Hot, Fengzhen, Baotou, Ulashan, Wuhai, and other places in the west. An unprecedented excellent situation has appeared

on the electric power battlefront. Inner Mongolia added 554.5 MW in new installed generating capacity during 1989. Especially noteworthy is the startup of the first 200 MW generator at Fengzhen Power Plant that was designed, built, debugged, operated, and managed by Inner Mongolia itself, which is an indication that Inner Mongolia's electric power industry has moved up to a new stage in building and managing large generators. In 1989, Inner Mongolia generated 15.328 billion kWh of power, up 11.92 percent over 1988. According to incomplete statistics, Inner Mongolia now has a total installed generating capacity of 3,300 MW including thermal power, hydropower, wind power, train power, and diesel generators that are making new contributions to alleviating Inner Mongolia's power shortage. Another 500 MW of installed generating capacity will be added in 1990.

Inner Mongolia's electric power construction industry is now advancing with giant strides on a thriving and prosperous broad road. In the past 10 years, the state adopted slanted policies and plans to invest over 30 billion yuan focused on supporting coal, electric power, communications, and other basic industries in Inner Mongolia. They have focused on developing Jungar and Dongsheng Coal Fields and building combined coal and power energy resource base areas, and they have decided to build several new medium-sized power plants along the 780 kilometer-long banks of the Huang He, such as Haibowan, Jungar, Dongsheng, Daihai, and other power plants, and to expand Fengzhen, Hohhot, and other power plants. Preparatory work for Haibowan, Dongsheng, Daihai, Togtoh, and other power plants is now in progress. The State Energy Resource Investment Company has already reached an agreement with the government of Inner Mongolia Autonomous Region concerning Dalad Power Plant for a joint investment in the first phase project with a construction scale of four 300 MW generators during the Eighth 5-Year Plan and later to use 600 MW and larger generators to ultimately build Asia's largest thermal power plant with an installed generating capacity of 5,000 MW. This would increase the grid capacity in western Inner Mongolia 5,600 to 8,000 MW.

Three leagues in eastern Inner Mongolia will integrate with the three big Huolin He, Yimin He, and Yuanbao Shan open-cut coal mines and Baorxil Mining Region to build matching projects for new construction of Yimin He Power Plant, Hailar Power Plant, Huolin Ne Power Plant, and Youzhong Power Plant and expansion of Yuanbao Shan Power Plant and Tongliao Power Plant. This will increase the total installed generating capacity to 10,000 MW.

This commanding vanguard will actively contribute forces to achieving the short-term strategic goals for the three projects in Inner Mongolia Autonomous Region and will provide a steady flow of abundant electric power for transmission to all areas of northeast and north China.

A Brief Introduction to Inner Mongolia's Main Power Plants

1. Baotou No 1 Heat and Power Cogeneration Plant. This plant has one 12 MW generator, two 25 MW generators, one 50 MW generator, and two 100 MW generators, for a total installed generating capacity of 312 MW. Construction of a 100 MW generator is now moving ahead feverishly and it may go into operation during 1990.

2. Baotou No 2 Heat and Power Cogeneration Plant. This plant has two 25 MW generators, three 50 MW generators, and two 100 MW generators, for a total installed generating capacity of 400 MW.

3. Hohhot Power Plant. This plant now has two 12 MW generators and two 25 MW generators, for an installed generating capacity of 74 MW.

4. Ulashan Power Plant. This plant has two 50 MW generators and one 100 MW generator, for an installed generating capacity of 200 MW.

5. Fengzhen Power Plant. Plans for the first phase of this project call for installing four 200 MW generators. Construction began on 1 July 1986 and the first 200 MW generator was connected to the grid and began generating power on 30 September 1989. The second 200 MW generator will begin operating in 1990.

6. Yuanbao Shan Power Plant. Construction of this plant began in 1975 and the first 300 MW generator went into operation in 1978. The second phase project, Inner Mongolia's biggest thermal power generator at 600 MW, went into operation in 1985. The plant now has an installed generating capacity of 900 MW.

7. Tongliao Power Plant. Construction began in 1977. The first 200 MW generator went into operation in August 1985 and the second 200 MW generator went into operation in December 1985. The No 3 generator went into operation in December 1989. This plant now has an installed generating capacity of 600 MW.

Work Begins on Zhengzhou Expansion Project

906B0105A Zhengzhou HENAN RIBAO in Chinese 17 Jul 90 p 1

[Article by reporters Li Changhong [2621 6855 5116], Pi Dianling [3968 3013 1545], and Li Jinsheng [2621 6855 5116]: "Ground Breaking at Zhengzhou Heating and Power Plant Project"]

[Excerpts] The Zhengzhou Heating and Power Plant expansion project was inaugurated on 15 July. [passage omitted]

The addition of 2 x 200,000 kW heat supply units is a joint investment project of the Zhongxin Corporation and the Zhengzhou Municipal People's Government. The total investment is 523 million yuan; the Xinli

Energy Development Company of the Zhongxin Consortium invested 240 million yuan. After completion of this expansion project, there will be major changes in the industrial structure of Henan Province; in addition, appreciable economic and social benefits will be brought to Zhengzhou.

Today, there are power shortages in Zhengzhou with a 25 percent shortfall for industrial power. After completion of the expansion (two units at Zhengzhou heating and power plant) by the end of 1992, there will be an annual increase of power supply of 1.786 billion kWh. With the present output increase of 2.85 yuan per 1,000 kWh at Zhengzhou, there will be an industrial output of more than 5 billion yuan. In addition, an additional heat supply of 6.427 million kilojoules per year will be available to Zhengzhou; the heat supplied in the form of hot water between 70° and 120°C will provide winter home heating for 140,000 households, in addition to 200 tons of steam per hour for industrial production. As a result, 359 small, inefficient boilers can be retired for an annual saving of 600,000 tons of raw coal. Each year, the following pollutants in the Zhengzhou basin will be reduced: 13,500 tons of sulfur dioxide and 4,952 tons of smoke and ash. Then the air quality in Zhengzhou will be much improved. [passage omitted]

Jiaozuo Power Plant Expansion Accelerated

906B0105B Zhengzhou HENAN RIBAO in Chinese 18 Jul 90 p 1

[Article by Huang Xijing [7806 6932 2529] and Lin Shukui [2651 2579 1145]: "Peak Construction Under Way on the Expansion Project of Jiaozuo Power Plant; Power Networking Commenced in the First-Stage Project at the Second Power Plant of the Zhongyuan Oil Field"]

[Excerpts] By HENAN RIBAO reporter Liu Jialin [0491 1367 2651]—The third stage expansion project of Jiaozuo Power Plant has entered a stage of peak construction.

Since completion and operation of the first- and second-stage projects of the Jiaozuo Power Plant in 1980 and 1986, four 200,000 kW steam turbine generators have produced 35,398.56 million kWh of power with a direct output value of 2,061.88 million yuan and an increase in industrial output valued at more than 100 billion yuan. Last year, the power plant was listed as a major state enterprise.

The third-stage expansion project was inaugurated on 20 December 1989; the capacity of installed power units is 2 x 200,000 kW, with a total investment of 317.41 million yuan. It is required that power units No 5 and No 6 be completed, with power generation beginning in 1991 and 1992. [passage omitted]

As reported by HENAN RIBAO, on 8 June the first stage project of the No 2 power plant (installed capacity: 36,000 kW) at the Zhongyuan oil field began operations and joined the grid. The power unit is operating smoothly with a daily power output of 880,000 kWh.

As a state key construction project, the No 2 power plant of Zhongyuan oil field is an item that is coordinated with other projects for an annual oil field output of 10 million tons of crude oil. This is a modern steam power plant using natural gas combustion. Complete sets of equipment and technology were imported and licensed from the Brown Company of Britain. The total investment is more than 94 million yuan. The power plant project is divided into two stages: the first stage is mainly a power generation project utilizing natural gas, an oil field by-product. Formal ground-breaking and initial construction took place in September 1987; this stage was contracted to the Sixth Engineering Construction Company of the China Petroleum and Natural Gas Corporation. For high quality in engineering construction, the Hydropower Construction Company and the No 2 power plant of the Zhongyuan oil field carefully inspected every piece of imported equipment to assist the contracting units in overcoming difficulties. [passage omitted] The second stage is scheduled to be completed in November this year. After power begins to be generated, the plant will have a daily power generation as high as 1.28 million kWh, thus relieving power shortages in the Zhongyuan oil field.

Construction Begins on 2400 MW Tieling Plant

40100001B SK1609060590 Shenyang Liaoning Provincial Service in Mandarin 0930 GMT 15 Sep 90

[Summary] The construction of the Tieling power plant (total investment: nearly 1.9 billion yuan), a state key project, formally began today. Located in Tieling City, this power plant is Liaoning's first pit-mouth power plant and has a generation capacity of over 1 million kW. The first generating unit will go into operation in 1993. The first-phase project of four 300,000-kW generating units will be put into full operation by the end of 1995. It is expected that the annual power generation output will exceed 7.8 billion kW, an equivalent of 10 percent of the planned power consumption of the whole province in 1995. After the completion of the second-phase project, the total installed capacity will be 2.4 million kW, making the plant the largest in the northeast.

Technology Boosts Coal Production

40100006A Beijing CHINA DAILY in English
1 Oct 90 p 2

[Article by Chen Weiwen]

[Text] Datong, Shanxi Province—Roaring, rolling, moving to and fro, a huge mining machine rips coal from a seam 160 metres underground.

But gigantic as it is, the modern machine is run by just 45 workers divided into three shifts. With it, they can extract up to 1.2 million tons of coal a year.

The miners who operate this giant machine are one of the 32 fully mechanized teams of the Datong Coal Administration, the largest coal base in China's Shanxi Province. Throughout the country there are 445 similar mining teams.

Wang Cao, a 33-year-old father of two, says he enjoys a much better life and working conditions than his miner father did. "The improvements are all thanks to the new mining machine," he said.

Sitting in front of the control panel and pressing buttons now and then, Wang, part of a 15-member team, said that he and his colleagues could produce more than 4,000 tons of coal a day.

For Wang's father, now retired, life was not so easy. He had to work 16 hours a day under poor working and safety conditions. He had only his muscle power with which to dig and haul coal and heavy tools. Serious accidents were commonplace.

Thirteen collieries in the Datong Coal Administration have now been fully or partially mechanized. The level of mechanization in its pits reached 88.83 per cent last year.

The administration, which employs 140,000 workers, operates directly under the China National Coal Corporation, and mines China's largest coal field. It produced more than 34 million tons of coal in 1989, 414 times more than the output in 1949.

Mechanization

The average level of mechanization in the 97 State-controlled coal mines has reached 62 percent. Some of them, like the Lu'an coal mine in Shanxi, have achieved full mechanization covering every step of production.

Thanks to the development of mining technologies and massive investment, China's coal production has been developing steadily, with an annual growth rate of 9.13 percent since 1949.

Last year, China's coal production hit a record high of 1 billion tons, making the country the largest coal producer in the world.

Back in 1949, the country's annual coal output was only 32 million tons.

About half of China's coal production is achieved by the 97 State-owned mines. The rest comes from collective or private mines, which number about 81,500.

The big increase in coal production in recent years is attributed largely to the policies of the central government. From 1986 to 1990, the industry received investment totalling 31.5 billion yuan ($6.69 billion).

In addition to massive financial backing, the government has put great effort into developing mining technology.

Today, China has 122 factories specializing in making coal mining machinery. The domestically produced equipment has helped many mining teams to achieve outputs of one million-plus tons of raw coal annually.

To improve the scientific level in the coal industry, a research system has been established. Among the many research organizations across the country is the China Coal Mining Research Institute, which has some 8,000 research staff and has brought many advances to the production of coal.

Safety

Better technology has also brought better safety conditions to coal workers. Most of the State-controlled coal shafts now have automatic safety-monitoring systems, as well as up-to-date rescue equipment. More than 30 safety training centres have been established across the country, and over 115,000 workers have been trained.

As China's major source of energy, coal will be the mainstay of the nation's energy supply for several decades to come.

Despite the big increase in coal output, demand is such that shortages will persist.

According to predictions by energy experts at home and abroad, China will need at least 1.45 billion tons of coal each year by 2000. To satisfy the future need, the State has decided to focus on the development of key coal areas in Shanxi, Inner Mongolia, and several other "coal provinces".

It has already managed to attract foreign capital to boost the country's coal production. In the past 10 years, the coal industry used $1.7 billion of investment from abroad to develop 12 projects, with a total production capacity of 49.2 million tons.

The Antaibao No 1 Opencast Coal Mine in Pingshuo, Shanxi, for example, is a joint venture between China and the Occidental Petroleum Corporation of the United States. With a designed annual production capacity of 15 million tons of coal and a total investment of $650 million, the venture is the largest Sino-US joint enterprise.

Since the open policy was applied a decade ago, China has exported its coal to 24 countries and areas worldwide.

In the first five months of this year, China earned $240 million from exporting 6.27 million tons of coal.

Based on several decades of prospecting and exploration, experts believe that there are potential coal reserves of about 870 billion tons no deeper than 2,000 metres underground.

Curtain Goes Up on First Phase of Jungar Project

906B0074A Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 22 Apr 90 p 2

[Article by reporter Hu Zuo [5170 1563]: "Curtain Opens on Construction of First Stage Project at Jungar Coal Field—A Sleeping Land Is Awakening Everywhere"]

[Text] On 21 April 1990, several 10 bulldozers, excavators, and heavy trucks began working feverishly on the Ordos Plateau as the roar of motors aroused a vast ancient coal deposit from its slumber. This indicates that engineering to prepare for construction of Heidaigou Strip Mine, the main part of the Jungar project, has formally begun and the curtain has opened on the first phase of project construction at the Jungar integrated coal, power, and railway project, the largest coal construction project since the nation was founded.

Jungar coal field is located in western Inner Mongolia and adjoins the Huang He on its eastern and southern sides. It is 127 kilometers from Hohhot City. The total area explored covers 1,365 square kilometers and geological reserves of 26.8 billion tons have already been proven. The coal is of excellent quality. It is long flame coal with low sulfur, low phosphorous, and moderate ash contents. The State Council made the first phase project to develop Jungar coal field a key national project in 1990. This is the biggest construction project in China's coal industry in the past 40 years. The Jungar project is an integrated coal, power, and railway project. The construction scale of the first phase project is yearly raw coal output of 15 million tons and a strip mine coal dressing plant with a similar washing capacity. A single-track electrified railroad with a yearly haulage capacity of 15 million tons will run in a straight line 215.6 kilometers long from Fengzhen to Jungar. A pit-mouth power plant with an installed generating capacity of 200 MW will be built. The entire project will begin producing coal, transporting coal, and generating power in 1993. The total investment is 4,092,500,000 yuan renminbi.

Engineering to prepare for construction of Heidaigou Strip Mine, the main part of the project, is building the mine roadway and dumping yard and the plant grounds leveling project according to construction organization design requirements. Implementation of this phase of the project will avoid repeated movement of the soil and is a positive way to reduce the construction schedule. To save time and increase speed, Jungar Coal Industry Company solicited and entered bids, divided the preparatory engineering to strip 15 million cubic meters of overburden into eastern and western areas, and awarded contractual responsibility for each part of the No 2 Metallurgical Construction Company in the Ministry of Metallurgical Industry and the No 19 Engineering Bureau in the Ministry of Railways, respectively. These two units will complete the stripping of 8 million cubic meters of overburden in 1990.

Jungar Coal Industry Company is implementing unified planning, unified construction, unified management, and unified administration for the entire project.

Agreement Signed With Japanese Interests on CWM Venture

906B0074B Beijing RENMIN RIBAO OVERSEAS EDITION in Chinese 20 Feb 90 p 1

[Article by reporter Pan Yanxi [3382 5888 5045]: "Yanzhou Coal-Water Mixture Company, Ltd. Signs Contract in Big Project To Utilize Foreign Investments for China's Energy Construction"]

[Text] Yanzhou Mining Bureau, a Chinese unified distribution coal mine, signed a joint venture contract with Japan's Iwai Corporation and JGC Corporation for the "Yanzhou Coal-Water Mixture [CWM] Company, Ltd." on 19 February 1990.

"Yanzhou CWM Company, Ltd.," located near Shijiu Harbor at Rizhao City in Shandong Province, will cover 72,000 square meters of land and involve a total investment of about 3.8 billion Japanese yen. This is the largest project utilizing foreign investments for energy resource construction in China since June 1989.

CWM, a new type of fuel that substitutes coal for oil, was developed internationally after the 1970's. It is made by mixing a specific proportion of powdered coal of different granularity with a specific amount of water and additives. Compared to coal, it has the advantages of producing less pollution, higher efficiency, ease of loading, storage, transport, and combustion, and so on. It has flow and stability characteristics like those of petroleum and can easily be transmitted over long distances by pipeline. China included CWM technologies among projects to attack key scientific research problems in the early 1980's.

This company will utilize advanced management methods and apply technologies from JGC Corporation to produce high concentration CWM. In the initial stages, the design capacity is 250,000 tons and the joint venture timetable is 20 years. All of the products will be exported.

Huolinhe Among Nation's First Truly Modern Mines

906B0074C Hohhot NEIMENGGU RIBAO in Chinese 19 Mar 90 p 1

[Article by reporters Liu Guoxin [0491 0948 2450] and Wang Shiqing [3769 0013 3237]: "Southern Strip Mine in Huolinhe Mining Region Has Become One of China's First Two Modernized Strip Mines"]

[Text] Southern Strip Mine in Huolinhe Mining Region, which has 12.9 billion tons of coal reserves and will use a full set of imported mining equipment, was examined and accepted by the Ministry of Energy Resources on 12 March 1990. Like Haizhou Strip Mine at Buxi in Liaoning, it has moved into the ranks of China's modernized strip mines. These are the first two modernized strip mines examined and approved by China since the state examined and approved construction of 10 shaft mines in 1985.

Since going into operation in 1984, the goal of Southern Strip Mine has been to become a national modernized strip mine. It has focused comprehensively and intensively on developing management and upgrading activities and has exceeded its coal production quotas every year, setting the record of no deaths in producing 10 million tons of raw coal among China's open-cut coal mines. Production and operation in this mine relies entirely on microcomputer operations. Full-staff raw coal efficiency is 5.91 tons/manshift, the highest in the industry in China. In this examination and acceptance, Southern Strip Mine attained or surpassed Chinese modernized strip mine standards in the five areas of safe production, full-staff productivity, production tasks, profit indices, and stable production.

Construction 'Feverish' at Shanxi's Big Coal Projects

906B0074D Taiyuan SHANXI RIBAO in Chinese 23 Mar 90 p 1

[Article by reporters Liu Guilan [0491 2710 5695] and Shang Jinsheng [1424 2516 3932]: "Lively Construction at Key State Projects in Shanxi, Coal Chemistry Base Area Construction Leaps Into New Stage, Four Single Projects Going Into Production To Add 8 Million Tons in New Coal Mining Capacity and 510 MW in Installed Generating Capacity in 1990"]

[Text] Construction of the Shanxi Coal Chemistry Base Area has now leapt into a new historical stage. A huge army of 60,000 is now fighting from south to north Shanxi at 11 key state construction project work sites.

Construction of Shanxi Coal Chemistry Base Area will affect the entire national economy and is of extremely great concern to the CPC Central Committee and State Council. Since the Sixth 5-Year Plan, the state has invested 14.4 billion yuan to arrange 23 key state construction projects in Shanxi Province in energy resources, communications, raw materials, the chemical industry, and other ares. In the past 8 years, through substantial support from all regions of China and arduous efforts of the builders, 12 key projects and part of the single projects for other projects have been completed. They have added 20 million tons in new coal production capacity, 3,550 MW in installed generating capacity, and over 200 million tons in yearly transport capacity. The 11 key projects where construction is now progressing feverishly in 1990 are: Gujiao Mining Region, Datong Mining Region, Yangquan Mining Region, Lu'an Mining Region, Jincheng Mining Region, Zhangze Power Plant, Shentou No 2 Power Plant, Taiyuan No 1 Power Plant, Daqin [Datong-Qinhuangdao] Railroad, Shanxi Aluminum Plant, and Houyue [Houma-Yueshan] Railroad. The total investment in these 11 projects during 1990 will be 2.68 billion yuan, an increase of more than 400 million yuan over 1989. A total of four single projects are planned for completion and startup in 1990: Malan Mine and Dongqu Mine in Gujiao Mining Region, the No 4 generator at Zhangze Power Plant, and the No 1 generator for the 5th phase of Taiyuan No 1 Power Plant. When these projects go into operation, they may add another 8 million tons in coal production capacity and 510 MW in installed generating capacity.

The Shanxi Provincial CPC Committee and Shanxi Provincial Government have been extremely concerned with construction of these key projects and the sons and daughters of Shanxi Province are making major efforts to support construction of these key projects just like they did on the front lines during the war years. On 17 March 1990, the Shanxi Province Key Project Leadership Group held an on-site conference at Taiyuan No 1 Power Plant where Shanxi Provincial Vice Governor Wu Junzhou [0702 0193 3166] made concrete arrangements to implement the CPC Central Committee principles of improvement and rectification and focusing on key project construction in Shanxi Province. A new high tide of construction will be appearing at the construction sites for these 11 projects and new luster will be added to Shanxi Province.

1. Gujiao Mining Region. The construction scale is five mines and five coal dressing plants which will produce 16.5 million tons of raw coal annually. Construction began in December 1978 and they have already completed Xiqu Mine and Zhenzhengdi Mine. Completion of Malan Mine and Dongqu Mine are planned for 1990 and they will have an annual production capacity of 8 million tons.

2. Datong Mining Region. Expansion began in 1979. The expansion in capacity will be 13.65 million tons and the budgeted investment exceeds 1.4 billion yuan. They have already completed Yanzishan Mine with 4 million tons in yearly output and Yanzishan Coal Washing Plant with a yearly coal washing capacity of 4.5 million tons. Sitaigou Shaft Mine, which will produce 5 million tons of raw coal annually, will be completed in 1990.

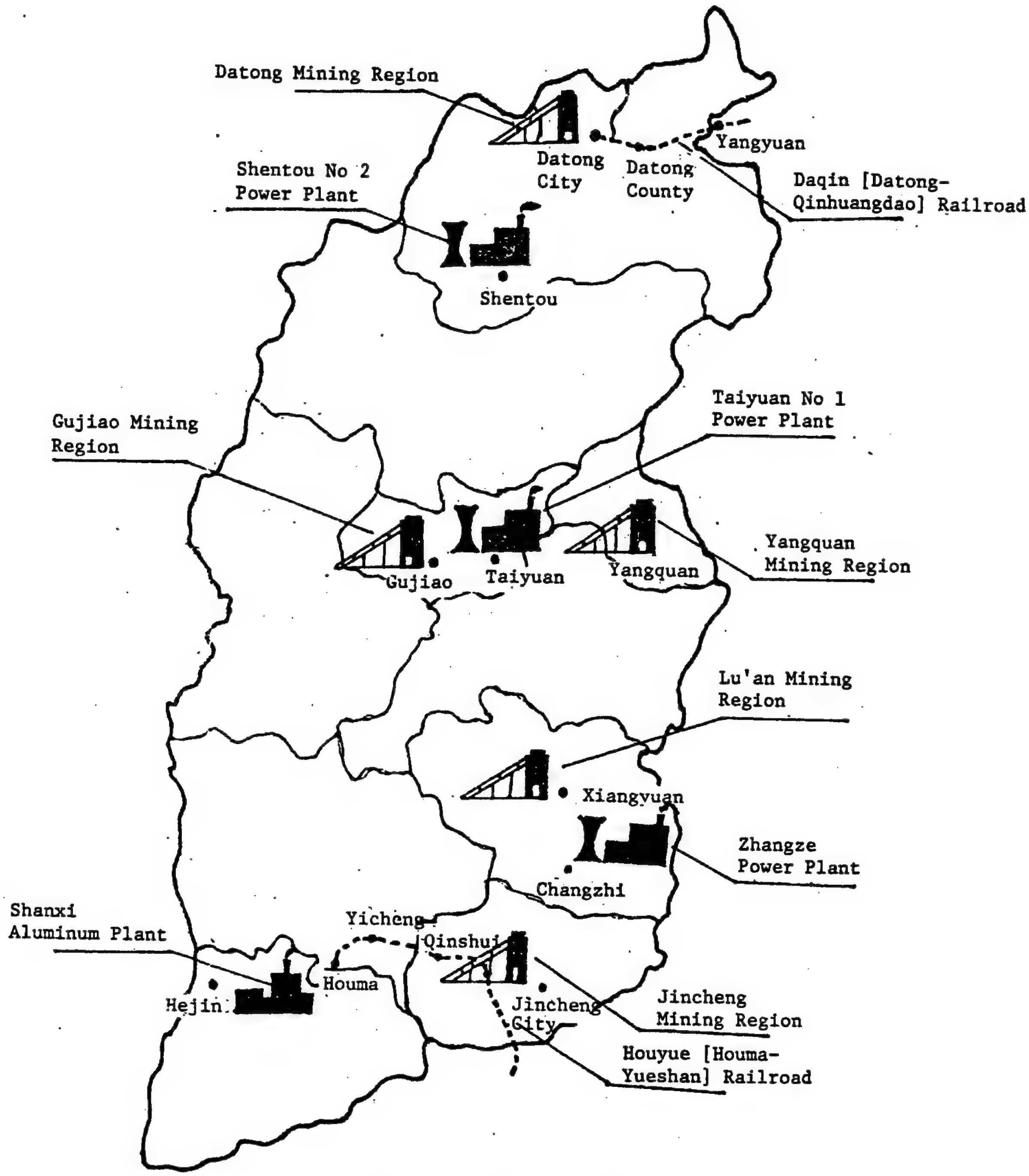

Figure 1. Location of Key Projects

3. Yangquan Mining Region. This mining region extends into three counties: Pingding, Mengxian, and Xiyang. In 1984, the state invested 930 million yuan on projects under construction in Yangquan Mining Region to expand and build seven projects including four raw coal production mines with a total yearly design capacity of 7.84 million tons and three coal washing (dressing) plants with a total design capacity of 8.85 million tons. All these projects may be completed and go into operation in 1991.

4. Lu'an Mining Region. This mining region extends into the suburbs of Changzhi City and the three counties of Lucheng, Xiangyuan, and Tunliu. The scale under construction in the mining region is 20 million tons in yearly

output. Changcun Coal Mine, where construction began in 1985, involves total investments of 561 million yuan and has a design capacity of 4 million tons. A coal washing plant with a yearly raw coal washing capacity of 2 million tons is also being built.

5. Jincheng Mining Region. Construction of this mining region is divided into two parts. The yearly production capacity of Fenghuangshan Mine and Gushuyuan Mine in the old region which was 1.5 million tons and 1.8 million tons, respectively, will be expanded to 4 million tons and 3 million tons, and a coal washing plant with an annual raw coal washing capacity of 3 million tons is also being built. The investment in construction in the new region is 3.3 billion yuan, used for two 4 million ton mines and two 6 million ton mines. Construction of the 4 million ton Chengzhuang Mine is now under way.

6. Houyue [Houma-Yueshan] Railroad. Houyue Railroad will connect with the Southern Tongpu [Datong-Mengyuan] Railroad at Houma in Shanxi Province and will run through Yicheng and Qinshui to the Jiaozhi [Jiaozuo-Zhicheng] Line at Yueshan in Henan. It will run for a total length of 252.6 kilometers, of which 197.2 kilometers will be within the borders of Shanxi, and the total investment will be 1.68 billion yuan. Construction began at the end of 1988 and when it is completed in 1993 it will be another route through which Shanxi coal can be shipped to other areas.

7. Zhangze Power Plant. The eventual installed generating capacity will be 1,040 MW. The project is being built in two stages. The first stage involved installation of two 100 MW generators and was fully completed and began operation in 1986. The second stage involves installation of four 210 MW generators imported from the Soviet Union at a total investment of more than 900 million yuan. One generator began operating and generating power at the end of 1989. The state plans to put two more units into operation in 1990 and another unit into operation in 1991.

8. Shentou No 2 Power Plant. This is another large pit-mouth power plant to be built following completion of Shentou No 1 Power Plant (1,350 MW), which was completed and began operating in 1987. The total design installed generating capacity is 2,200 MW. The first phase of the project involved installation of two 500 MW Czech generators at a total investment of 1.497 billion yuan. The state has asked that two more generators be placed into operation in 1991 and 1992, respectively.

9. Taiyuan No 1 Thermal Power Plant expansion project. Construction began in November 1987. The total installed generating capacity will be 600 MW. Two 300 MW bleeder heat supply generators will be installed at a total investment of 690 million yuan. The state has asked that the first generator be completed and placed into operation in 1990 and the second generator will be completed and placed into operation in 1992.

10. Shanxi Aluminum Plant. The long-term scale is 2 million tons of aluminum oxide, 300,000 tons of electroplating aluminum, 900,000 tons of cement, and 100,000 tons of aluminum processing. The first stage of the project for 200,000 tons of aluminum oxide has already been completed. Construction of the second phase of the project for 1 million tons of aluminum oxide began in November 1986. The total investment is 1.85 billion yuan. Plans call for 200,000 tons to go into operation in 1990. The second phase project will be finished and go into operation in 1993. At that time, this plant will account for 38 percent of total aluminum oxide output in China.

11. Daqin [Datong-Qinhuangdao] Railroad. It will start in the west at Datong's Hanjialing Station and run eastward to Qinhuangdao over a total length of 650 kilometers, passing through Shanxi, Hebei, Beijing, and Tianjin. The total investment for the entire line will be 4 billion yuan. Construction of the first stage of the project began in 1985 and construction was completed in December 1988. Completion of the second phase of the project is expected in 1991. The Daqin Line is China's first modernized railroad opened to heavy loaded unit train traffic.

Ways Sought To Resolve Sichuan's Shipping Bottlenecks

906B0074E Beijing JINGJI RIBAO in Chinese 14 Mar 90 p 2

[Article by Yang Zhanhui [2799 3277 2547], assistant researcher in the State Planning Commission Comprehensive Shipping Institute: "Viewing Construction of Southwest China's Shipping Networks From the Perspective of Coal Shipments Into Sichuan"]

[Text] **I. Shipments of Coal Into Sichuan Have Become a Point of Heated Concern**

According to plans and projections from the relevant areas, there will be a substantial increase in demand for coal in Sichuan Province in the short term. Deducting coal output in Sichuan Province itself and energy conservation measures that can be adopted, Sichuan Province's projected coal shortages will be 5 million tons in 1990, 10 million tons in 1995, and 15 million tons in 2000, which will have to be shipped in from other provinces. Moreover, there are also definite advantages to shipping a certain amount down the river from small local coal pits in east Sichuan. Sichuan's coal shortage problems may be solved mainly by transfers within the southwest part of Sichuan in 1990, but the overall trend for in-shipments of coal from 1995 to 2000 will be that roughly half will be shipped into Sichuan from the south and half from the north. There will be definite problems with railroads running into Sichuan from the south and north.

The main sources of coal from north China are Weibei coal from Shaanxi and Huating coal from Gansu. Because both the Baocheng [Baoji-Chengdu] Line and

Xiangyu [Xiangfan-Chongqing] Line are already in a saturated state, they will be unable to meet the need for increased freight volume in the future, so in the past few years the relevant departments have advocated building the Xikang [Xi'an-Ankang] Railroad and reinforcing the Xiangyu Line (including expanding the capacity of the Ankang-Daxian section and electrification of the Daxian-Chongqing section), expanding the capacity of the Baocheng Line, and so on. Because of the great difficulty and high investments involved in building the Xikang Line, although the State Planning Commission established the project back in April 1987, construction has still not begun. Added to the need for matching construction of the Chengda [Chengdu-Daxian] Railroad to provide a final solution to the coal shortage problems of the Chengdu region, this made opening this route even more difficult.

Definite problems also exist with southern routes. After the recent electrification of the southern section of the Chuanqian [Sichuan-Guizhou] Railroad, the transport capacity is 12 million tons. However, 10.1 million tons of freight has already been arranged for shipment into Sichuan, so there is little surplus capacity. In addition, out-shipments from Kaiyang Phosphorous Plant will rise substantially and will rely mainly on the Chuanqian Line for shipment into Sichuan and transfer to the Chang Jiang. The transport capacity on the northern section after electrification is 20 million tons. Because of the increased freight volume of coal from Songzao and Nantong in Sichuan as well as other factors, it is also nearly full. It may be possible to complete electrification and transformation of the Chengkun [Chengdu-Kunming] Line, another important southern route, by 1998, but the northbound capacity of the northern and central sections will be saturated. The main reasons are the abundant iron ore reserves in the Panxi (Zhihua and Xichang) region where the mining scale has now reached 15 million tons of ore per year. The subsequent completion and operationalization of the second phase project at Pangang Steel Mill and the Panxi No 2 Base Area will mean that the iron ore extraction scale in the year 2000 will reach 40 million tons of raw ore annually. Besides that amount ferried over to Pangang Steel Mill, it will be concentrated at Qinggang (Baima Mine) and South Xichang (Taihe Mine) stations for shipment to Chengdu, and the yearly freight volume will be about 8 million tons. The coal freight volume will be about 4.5 million tons and the iron and steel freight volume will be 2 million tons. About 2 million tons of phosphorous ore from Yunnan and Guizhou will also be shipped to northwest regions and other areas via the Chengkun Line, and so on.

In summary, looking at transport development trends on routes involving southern and northern railroads, it will be hard to solve the problems of shipping coal into Sichuan in the future. This has become a point of heated concern for the relevant policymaking departments over the past few years.

II. My Views

1. Adjustment of flows could alleviate pressures on the northern routes. Statistics show that Baocheng and Xiangyu routes in northern Sichuan are bearing an excessive burden in handling freight on the eastern and southern routes (excessive in-shipments of 5.36 million tons and excessive out-shipments of 5.2 million tons). If one can say that the capacity is saturated on the Qiangui [Guizhou-Guangxi] Line of the southern route and that it is incapable of taking on the entire burden of the freight volume itself, then the scope of the draw of the eastern route is basically the region in the middle and lower reaches of the Chang Jiang. Thus, a substantial part of its freight volume could be handled by water-borne shipping on the Chang Jiang. The incoming and outgoing freight volume at Wanxian on the Chang Jiang in 1987 was, respectively, just 860,000 tons and 3.73 million tons. Calculated at an incoming and outgoing capacity of 10 million tons each, it is obviously very underutilized. Thus, it is not hard to imagine that flow adjustments could free up capacity equivalent to the Xiangyu Line that could be used to solve problems in hauling coal into Sichuan in the future.

2. Continued construction of the Neikun [Neijiang-Kunming] Line and opening the new Longzun [Longchang-Zunyi] Line could expand the capacity of the south Sichuan railway routes. The difficulties involved in expanding the freight capacity into Sichuan by northern routes do not arise solely from building the new Xikang Line outside Sichuan and Chengda Line inside Sichuan. Even more important is expanding capacity on the Baocheng Line and Xiangyu Line. The Baocheng Line passes through Qinling and the Xiangyu Line passes through the Daba Shan region and most of the regional sections are connected by bridges, which historically have been risky and difficult, and it would be very hard to adopt capacity expansion measures like building intermediate stations, lengthening station lines, increasing section routes, and so on. For this reason, two old lines in north Sichuan should be expanded rather than building two new lines in south Sichuan.

3. Converting Chishui He into a canal and reopening Guan He to traffic both could increase the amount of coal shipped into Sichuan. According to the relevant feasibility research reports, conversion of 128 kilometers of Chishui He to a canal could open it to flotillas composed of 500-ton grade barges that would have a downstream freight capacity of 2.5 million tons annually, of which 2 million tons could be used to ship coal into Sichuan. Guan He is the largest tributary on the right bank in the lower reaches of the Jinsha Jiang. It is the boundary between Sichuan and Yunnan Provinces in its lower reaches and enters Jinsha Jiang at Shuifu. Historically, Guan He has been a water-borne shipping link between Sichuan and Yunnan Provinces and the interior. After 1960, it became the most developed river for water-borne shipping in Yunnan. In 1980, shipping was abandoned because Yanshui [Yanjin-Shuifu]

Highway was built. Yunnan Province's water-borne shipping development plans call for building five key cascade water conservancy projects on the Guan He. This would open an 85.4 kilometer stretch of the river between Tuowan and Shuifu to traffic by flotillas of 500-ton grade barges with a yearly handling capacity of 4.8 million tons and it could be used to ship coal from Yunnan into Sichuan and out of the region.

Accelerating the Growth of the Natural Gas Industry

906B0089B Beijing RENMIN RIBAO in English 14 Jun 90 p 5

[Article by Ding Zhimin [0002 1807 2404], engineer in the China Petroleum and Natural Gas Corporation: "The Late Starter in the Energy Resource Family—Discussing Accelerated Development of China's Natural Gas Industry"]

[Text] Natural gas is a superior quality, clean fuel and an important raw material for the chemical industry. The world's natural gas industry has developed very quickly in the past several years and it is one of the three main pillars of energy resources. It now accounts for 20 percent of the world's energy resource consumption structure. Natural gas accounts for 30 to 40 percent of the energy resource consumption structure in some developed nations. What is the situation in China's natural gas industry compared with other nations at the present time, and what are its development prospects?

I. In a Development Stage of Rising to a High Tide

China has a long history of discovering and utilizing natural gas. There are records of "fire wells" in Sichuan dating back 2,000 years, but it has developed slowly for a long time. On the eve of liberation, China's natural gas output was just 10 million cubic meters. After new China was established and our petroleum industry developed, our natural gas industry also grew substantially. China has now developed over 90 gas fields and built 6,417 kilometers of long-distance natural gas transmission pipelines. China produced 14.49 billion cubic meters of natural gas in 1989, which broke through the hesitation for several years and set a historical record. Nearly 60 percent of our commodity gas was supplied for chemical fertilizer production. China has over 100 large, medium-sized, and small chemical fertilizer plants using natural gas as a raw material which produce about one-fifth of our total annual chemical fertilizer output. There has also been substantial growth in urban gas utilization. Many large, medium-sized, and small cities including Beijing, Tianjin, Chengdu, Chongqing, Shenyang, Zhengzhou, and others continue to use natural gas either wholly or partially. In addition, about 30 percent of our commodity gas is supplied to the chemical, chemical fiber, metallurgical, military, glass, ceramics, and other industries.

In the present environment of growing calls for environmental protection, natural gas has received attention from people because of its special advantages. According to estimates by energy resource experts, calculated on the basis of deriving an equivalent amount of energy, the amount of carbon dioxide produced by burning natural gas is only one-half that of coal and one-third that of petroleum. Discharges of particulates and nitrous oxides are also much lower than coal and petroleum. The benefits are even more apparent. In power generation, for example, integrated natural gas cycling technologies can make the thermal efficiency of natural gas much greater than the thermal efficiency of burning coal. According to estimates by relevant departments, the cost of burning coal in electric power departments is universally about 30 percent higher than burning natural gas. Added to savings in the environmental area from burning natural gas, the economic benefits are even more substantial.

II. Main Problems Facing the Natural Gas Industry

The main contradiction China's natural gas industry faces at the present time is the contradiction between society's ever-increasing demand for natural gas and the slow rate of growth in production. The main factors which restrict development of China's natural gas industry are:

1. Low proven natural gas reserves and an irrational ratio between oil and gas output. At present, natural gas is an energy resource that is not being fully utilized in China. China is rich in natural gas resources but has extremely low proven reserves that are far lower than the world's average degree of proven reserves. The ratio between oil and gas output is also irrational. The average world level is 1:0.62. This ratio is 1:1.02 in the United States and 1:1 in the Soviet Union, but just 1:0.1 in China. Moreover, most gas fields in operation in China are medium-sized and small ones. Most have entered the late stages of exploitation and lack reserve strengths, so stable output is very hard to achieve.

This irrational situation makes the energy resource consumption structure irrational. The world's average energy resource consumption structure is: coal 30.3 percent, petroleum 39.5 percent, natural gas 19.6 percent, hydropower 6.7 percent, and nuclear power 3.9 percent. China's present energy resource consumption structure is: coal 71.6 percent, petroleum 21.3 percent, natural gas 2.3 percent, and hydropower 4.8 percent.

2. Generally speaking, the size of the ratio between petroleum and natural gas in the energy resource consumption structure is an indicator of a nation's degree and level of industrialization. Beginning now, if China fails to be concerned with improving our energy resource consumption structure, our environmental pollution and coal transport problems will be even more serious by the end of this century.

3. The contradiction in natural gas output is becoming increasingly acute. All areas are now fighting to use gas and the momentum of expanded gas utilization is increasing, not slowing. Demand already exceeds supply. Many chemical fertilizer plants must determine output according to gas supplies. The capacity for selling commodity natural gas to outside buyers in some oil fields in central China during 1989 was less than 600 million cubic meters, but the amount of gas "allowed for distribution" by all levels has reached 1.4 billion cubic meters. Everyone is fighting for gas and emergencies are being declared everywhere.

4. Prices for natural gas are irrational. Prices of natural gas have been too low for quite some time and do not reflect true costs. China now sells natural gas for just 0.08 to 0.13 yuan per cubic meter. Calculated according to equivalent heat value, the price of natural gas is even lower than the price of crude oil, which formerly was low. Low prices restrict development of the natural gas industry, further stimulate consumption demand, and intensify the contradiction between supply and demand.

5. Investments are inadequate and systems are disorderly. For many years, most of China's natural gas has mainly been gas associated with petroleum. However, systems are disorderly and policies are not matched up in natural gas exploration, development, production, distribution, marketing, and other areas. Production and construction are one area, planning and allocation are another area, and administration and sales are yet another area. There are often many contradictions and much buck-passing, so it is hard for them to play a mutually promoting role. During system reforms in 1988, the Ministry of Petroleum Industry was changed to the China Petroleum and Natural Gas Corporation. Although the corporation expended some effort in this regard, many problems still remain unsolved. In 1965, when it produced 12.1 billion cubic meters of natural gas a year, the Soviet Union established a special Ministry of Natural Gas Industry to take responsibility for natural gas exploration, development, processing, and utilization for all of the Soviet Union. China now produces almost 14.5 billion cubic meters of natural gas a year but we still do "combined exploration for oil and gas" and "jointly manage oil and gas." The state's limited investments and problems in all administrative departments mean that they are concerned only with oil and not with gas.

Looking back over the past 40 years, the proportion of investments in China's natural gas industry has consistently been very low, about 10 percent of investments in petroleum and 2.5 percent of investments in the entire energy resource industry. Inadequate investments have seriously restricted development of China's natural gas industry.

III. Some Views on Accelerating Development of the Natural Gas Industry

1. Improve external conditions, make rational readjustments in natural gas prices. I propose that the state make rational readjustments in natural gas prices to enable enterprises to meet their costs and even make slight profits and prevent enterprises losing more money the more they produce. In addition, we should suitably deregulate prices for over-quota production to encourage increased output and conservation. The amount of over-quota gas with negotiated prices in China is limited now and has no effect on the market as a whole. Moreover, it enables users with high benefits to use more superior quality energy resources or raw materials. To encourage and support natural gas exploration, development, and intensive processing, prior to straightening out natural gas prices, I propose that the state implement tax reduction and exemption policies for policy-type losses or "first requisition and then return" them for use as a natural gas exploration and development fund.

2. Change the investment and production system in which usually only the state makes investments, open multiple channels for investment. Implement state and local investments, capital raising by enterprises themselves, and various other investment arrangements. Adhere to the principle of those who invest being those who benefit and attract capital from many areas to compensate for inadequate state investments.

3. Reinforce specialized management and scientific research for natural gas. In today's world, natural gas is already an emerging industrial sector and has formed an integral industrial system from exploration and development to processing and utilization. How can we accelerate development of China's natural gas industry? Given China's national conditions, oil and gas production cannot be totally separate, so we cannot apply models from foreign countries. The China Petroleum and Natural Gas Corporation has accumulated rich experience in oil and gas exploration, development, production, management, and other areas over the past 40 years and it has enormous strengths. The problem now is that because of China's disorderly natural gas management system and other reasons, the China Petroleum and Natural Gas Corporation cannot solve problems as they appear. If we want faster development of China's natural gas industry, an urgent task now is to solve the problem of disorderly management systems. We must resolutely adhere to the principle of "working on oil and gas at the same time" and overcome the ideology of "focusing on oil while neglecting gas." Within the corporation, of course, we should further reinforce management and planning of natural gas production and development. Consideration can be given to separate listings and investments for natural gas in plans at the present stage. The state can also relax authority over production, supplies, and sales by natural gas producing enterprises as appropriate.

A great deal of data from China and foreign countries shows that gas associated with petroleum accounts for only about 5 percent of total natural gas reserves while pure gas pools account for up to 95 percent of reserves. Nearly 70 percent of China's current gas output is associated gas. We also lack sufficiently extensive research on laws of natural gas formation, migration, and accumulation and on development and utilization. For this reason, I propose that a national natural gas scientific research organ be established and that natural gas exploration and development and other specializations be established in petroleum institutions of higher education to reinforce scientific research on natural gas and the training of specialized technical personnel.

Nation Set To Tap Tarim Reserves

40100006B Beijing CHINA DAILY (Economics and Business) in English 9 Oct 90 p 2

[Article by staff reporter Xu Yuanchao: "China Set To Tap Tarim Oil Reserves"]

[Text] China yesterday announced its plan to set up its first pilot oilfield next year in the Tarim Basin, in the country's northwest.

According to experts, the so-far untapped Tarim Basin oil reserves could replace the waning supplies of major wells in the country's east.

The experts estimate the Tarim oil and gas reserves hold up to 12 billion tons, about one-fifth of the country's proven oil reserves.

An official from the China National Oil and Gas Corporation told CHINA DAILY yesterday the pilot scheme at Tarim would begin late next year.

The pilot oilfield is about 40 kilometres south of Luntai County in northwest China's Xinjiang Uygur Autonomous Region.

The official said 27 oil wells had been sunk in the area—16 had oil of commercial value and the other 11 were being tested.

The Basin wells, where the pilot oilfield will be based on, were expected to turn out 1 million tons of crude oil next year, and would produce 150,000 tons by the end of this year, said the official, speaking on condition of anonymity.

Preparations are currently underway to get ready for the launching of the pilot oilfield next year, the official said.

Pipelines would be laid to Luntai, from where the crude oil would be transported by rail to Urumqi, capital of the region, for refining at the Xinjiang Petrochemical Plant.

Tests in September showed that a DH-1 well drilled in Donghetang near Kucha would be able to produce 837 cubic metres of oil and 5,852 cubic metres of natural gas each year.

The test well, about 100 kilometres southwest of Luntai, showed that oil reserves could cover 48 square kilometres.

The official said four oil wells were planned for the area next year because geologists believed the area was linked with the pilot oilfield in the southern part of Luntai.

Since the corporation set up its headquarters last April, 20,000 geologists and oil workers have been assigned to the area, which covers 560,000 square kilometres, including the 330,000 square kilometres of Taklamakan Desert.

Nearly 50 drilling machines had been rigged up in the area, the official said.

The central government has earmarked 15 billion yuan over the next two years to support the desert exploration project.

The United Nations provided $5 million in May to be used to solve drilling problems in the complicated geological conditions. This is believed to be the largest energy project funded by the United Nations.

The Tarim Basin will be listed in the Eighth Five-Year Plan (1991-95) as a major area for oil exploration, and oil experts say it will give impetus to China's oil industry over that period.

The official said the exploration work would be gradually extended from southern Luntai to the whole basin, and the corporation would be well prepared for large-scale exploitation by the turn of the century.

New Approach to Prospecting in Jiuxi, Turpan Basins

906B0088A Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 9 Jun 90 p 2

[Article by Wan Yansheng [8001 3601 3932]: "Jiang Hongxun [1203 3163 6064] and Others at Northwest China University Open New Routes for Oil and Gas Exploration and Achieve the Idea of Non-Conventional Multi-Parameter Direct Petroleum Exploration"]

[Text] Projects for "Integrated Geophysical and Geochemical Prospecting Direct Petroleum Exploration in the Qingxi Region of Jiuxi Basin" and "Integrated Geophysical and Geochemical Prospecting Direct Petroleum Exploration in Xinjiang's Turpan Basin" which were directed by Associate Professor Jiang Hongxun and others in Northwest China University's Geology Department recently passed examination and acceptance smoothly.

To deal with the special geological structures in these two regions, Jiang Hongxun and others were boldly innovative in proposing 11 methods and nearly 20 parameters for non-conventional multi-parameter direct petroleum exploration which integrate the three main disciplines of geology, geophysics, and geochemistry for direct exploration for petroleum.

With a scientific spirit of seeking truth, Jiang Hongxun and other comrades carefully studied geological conditions in the entire Qingxi region of Jiuxi Basin prior to construction and carefully designed an exploration program. After arduous field construction, careful data processing, and clear deduction, they achieved unprecedented prospecting results in delineating four oil and gas comprehensive anomaly regions and one oil and gas accumulation zone. There is excellent correspondence between the boundaries of newly measured anomalies in known regions and the boundaries of oil and gas fields demarcated through exploratory drilling and there is

complete identity between confirmed anomaly regions delineated via exploratory drilling in unknown regions and the expected results.

In Hami Basin, this new method was used to achieve basic identity between five oil and gas geochemical comprehensive anomalies delineated in the construction region and structural traps. Logging was done in one projected region and two wells produced industrial oil flow.

Wells outside the projected region produced only water and no oil. This result shows that the multi-parameter integrated oil prospecting methods used by Jiang Hongxun and others are advanced and reliable.

Liaohe Using New Technologies To Recover 'Dead Oil'

906B0088B Beijing RENMIN RIBAO in Chinese 4 Jun 90 p 1

[Article by Liu Xieyang [0491 3610 7122] and Nie Wei [5119 0251]: "Breakthroughs in Developing Highly Condensed Oil and Dense Oil, Liaohe Oil Field Uses New Technologies To Substantially Increase Crude Oil"]

[Text] China has made a major breakthrough in technologies for developing highly condensed oil and dense oil at Liaohe Oil Field which have turned hard-to-extract "dead oil" into "live oil." Yearly crude oil output at Liaohe Oil Field has risen quickly from 8 million-plus tons to 13.35 million tons, making it China's third biggest oil field.

Liaohe Oil Field has complex geological structures, rich oil accumulations, and many product varieties. The solidifying point of highly condensed oil is as high as 67°C, making it the petroleum with the highest solidifying point in the world at present. The dense oil contains 40 to 60 percent bitumen. These two types of oil do not flow easily at normal temperatures. In conventional extraction, the crude oil merely solidifies at the bottom of a well and cannot be extracted, earning it the name "dead oil."

Extraction of highly condensed oil and dense oil is a big problem in the world at present and only a few nations are capable of extracting it from depths greater than 1,000 meters. The dense oil in Liaohe Oil Field is 1,800 meters deep, so it is even harder to extract. S&T personnel at the oil field borrowed experiences from foreign countries to create the "heat injection work method" and "well heat-proofing method" which allow dense oil to erupt to the surface easily. They use thermal insulation, electrical insulation, and other methods when extracting highly condensed oil to make the oil flow to the well surface without solidifying and flow very quickly into oil tanks.

These two big breakthroughs in extraction technologies have increased output from Liaohe Oil Field at a yearly rate in excess of 1 million tons.

Liaohe Oil Field's new extraction technologies have attracted attention from experts and scholars in China and foreign countries. These new technologies are now in wide use at other oil fields in China and they have received a first-place state S&T progress award.

East China Fields Set for Exploitation

906B0088C Shanghai JIEFANG RIBAO in Chinese 13 Apr 90 p 1

[Article by Zhang Hao [1728 6275] and Yang Zhouyi [2254 0719 1744]: "East China Sea Oil Field Prepares for Actual Extraction After 17 Years of Surveys and Comprehensive Research, Shanghai and Zhejiang Now Doing Preparatory Work"]

[Text] The oil and gas resources of East China Sea Oil Field which have attracted attention in China and foreign countries may enter the stage of actual exploitation beginning with development of Pinghu Oil and Gas Field. This will provide a basic means of alleviating energy shortages in the East China region. This was examined and approved on 12 April 1990 by the State Science and Technology Commission in the "East China Sea Continental Shelf Oil and Gas Resources Rolling Exploration and Development and Early Exploitation Debate Report" led by Professor Yang Jike [2799 4764 3784]. Relevant departments in Shanghai Municipality and Zhejiang Province are now making preparations to develop the oil field.

After 17 years of arduous efforts by geological departments, over 500,000 square kilometers of marine areas in the East China Sea have been surveyed and 208 oil and gas geological structures and strata have been discovered, confirming the gratifying prospects for developing the East China Sea Oil Field. However, it will continue to be rather difficult to make comprehensive deployments for industrial production due to the vast size of the oil field, the complexity of geological structures, the enormous investments required, and so on. This research achievement in the soft sciences was completed after 3 years of comprehensive research by experts in many disciplines that was organized on the basis of the above information by the East China Region Commission of the China Energy Resource Research Commission. It absorbed successful experiences accumulated internationally in the process of developing offshore oil fields during the 1970's to suggest the idea of rolling exploration and development. This refers to using existing conditions and limited financial resources to make breakthroughs in developing the entire oil field and taking the new route of using production to promote exploration. The experts applied data from the newly drilled Pinghu No 4 Well and used resource content, technical conditions, economic benefits, and other areas to debate conditions for early exploitation in Pinghu Oil and Gas Field. The concrete idea they proposed was to select a border oil field with rich accumulations of oil and gas in the East China Sea oil province, Pinghu Oil and Gas Field, as the starting point for developing the

entire oil field to carry out early production and sell oil and gas products and then use these funds to expand exploration over the next 2 to 3 years and develop several oil and gas deposits in the nearby western slope zone and the Pinghu, Yuquan, and Tianwaitian triangle region, use a "snowballing" arrangement to accumulate capital for comprehensive development, use this "window" to do additional research on oil reservoir characteristics and perfect overall development programs, and use actual operations to accumulate technical experience and managerial experience for marine oil field development to promote development of the entire oil field.

The relevant people feel that actually exploiting East China Sea Oil Field as soon as possible is very important for alleviating the shortages of energy resources and chemical industry raw materials in the East China region. Present production plans indicate that demand for petroleum in Shanghai Municipality and Jiangsu, Zhejiang, Anhui, Jiangxi, and Fujian provinces will reach 56.53 million tons in the year 2000. The maximum output of petroleum from continental sources in this region at that time will be 1.5 million tons, so there will be a substantial shortfall. However, estimated crude oil reserves of the East China Sea continental shelf are about 4 billion tons, so developing the East China Sea Oil Field undoubtedly would have major effects on invigorating the economy in the East China region.

Shengli Turns Attention to Shallow Sea Areas

906B0088D Shanghai JIEFANG RIBAO in Chinese 25 May 90 p 3

[Article by reporter Sang Jinquan [2718 2516 3123]: "Shengli Oil Field Attacks Shallow Sea Areas, Two Oil Deposits With Rich Reserves Already Discovered Offshore, Striving for Yearly Crude Oil Output of 34 Million Tons in 5 Years"]

[Text] The 190,000 "Shengli men" ["Victors"] who have fought for 26 years on the barren saline land of the Huang He Delta are now expanding the focus of oil and gas resource exploration and development work to offshore areas and expanding from marine areas off Shandong to the shallow sea along a line from Bohai Bay to Liaodong Bay. Achieving this shift and raising oil field development levels will ensure that Shengli Oil Field will have sustained and stable development on the basis of 8 successive years of stable increases in output and achieve crude oil output of 34 million tons by 1995, a net increase of 650,000 tons over 1989.

The information is that since Shengli Oil Field was developed, it now has proven petroleum geological reserves of several billion tons and has produced a total of 395 million tons of crude oil, equal to 19 percent of total crude oil output in China over the same period. It has also exported a total of more than 61 million tons of crude oil and earned US$8.4 billion in foreign exchange. However, the old oil fields which went into operation in the 1960's and 1970's have passed their peak periods and are now entering the period of decline. In the past few years, the average water content of their crude oil has risen to 78 percent and exceeds 80 percent in the highest cases. This means that 4 to 5 cubic meters of water must be injected underground to "drive out" 1 ton of oil. The oil field as a whole was able to achieve stable output only by shifting the focus of development and exploration and by exploiting potential and improvement of old oil fields to achieve sustained development.

Lu Renjie [7120 0086 2638], deputy director of daily business in the Shengli Oil Field Management Bureau, told reporters that two oil deposits with rich reserves have already been discovered in the offshore marine area inside a line marking water depths of 10 meters running from Laizhou Bay to Liaodong Bay. One is Cheng Island Oil Field which has proven reserves of 200 million tons and can be developed in the near future. A yearly production capacity of 1 million tons of crude oil may take shape by 1995. The second is Liaodong Bay Oil Field, which geologically speaking is an extension of Liaoning's Panjing Oil Field. Preliminary exploration has found oil and gas resources but the reserves and scope have not yet been determined. Plans call for a drilling platform to be moved into place during 1990.

Petroleum Prospectors Achieve 'Breakthrough' in Xinjiang

40100077A Beijing XINHUA in English 1411 GMT 11 Sep 90

[Text] Urumqi, September 11 (XINHUA)—Petroleum prospecting teams have achieved a breakthrough in the Tarim Basin, in northwest China's Xinjiang Uygur Autonomous Region.

An official from the prospecting headquarters told XINHUA that high-yield oil flows have gushed from more than 20 test wells so far. Dozens of other test wells also show good prospects.

The Tarim Basin, covering 560,000 sq km, is the biggest oil-bearing field in China. It is estimated that the oil and gas resources account for one-seventh and one-quarter, respectively, of the national total.

Because the basin is surrounded by desert, the natural conditions are hostile.

Oil exploration started in the Tarim Basin in 1952. During the 38 years of exploration, more than 300 technicians and workers have lost their lives.

Though oil fields were found in 1958 and 1977, the underground structure remained a riddle because of poor facilities and insufficient expertise.

In recent years the Geophysical Exploration Bureau of the China Oil and Gas Corporation has made seismic prospecting lines totaling 50,000 km and verified that the underground structure consists of "three upwarpings and four depressions" with several oil-bearing structures

of over 100 sq km each. The most prominent structure is the Tazhong No 1, covering 8,200 sq km.

They also found that the nearby Taklimakan Desert has rich underground water resources.

The seismic prospecting results show that the Tarim Basin has necessary conditions for oil reserves.

Since last spring the geological department of the China Oil and Gas Corporation has organized 17,000 workers from different parts of the country to conduct oil exploration in the Tarim Basin.

The prospecting teams have concentrated their efforts on exploring the northern and central parts of the basin.

In the Lunnan area, in the northern part of the basin, workers have drilled 36 wells, of which 19 have shown high-yield oil flows and the rest indicate oil- and gas-bearing strata.

Moreover, drilling teams organized by the Ministry of Geology and Mineral Resources have also drilled three high-yield wells in the southern part of the Lunnan area.

Since last June the prospecting headquarters under the China Oil and Gas Corporation has begun to trial-produce oil. The oil output will reach 150,000 tons this year and 1 million tons next year, according to headquarters officials.

In the central part of the Taklimakan Desert, where the Tazhong No 1 high-yield oil well is located, two more promising oil-bearing strata were found recently. Petroleum experts estimate that there may be a number of big oil and gas fields in the 8,200 sq km Tazhong No 1 structure.

Meanwhile, a special railway line is under construction, and when it is completed in October this year, oil produced in the Tarim Basin will be transported by rail to a petrochemical plant in Urumqi, capital of Xinjiang.

Developments in Three Xinjiang Basins Followed

906B0089A Urumqi XINJIANG RIBAO in Chinese 28 Mar 90 p 1

[Article by reporter Fan Yingli [2868 5391 0448]: "With Rich Mineral Reserves and Substantial Development Prospects, Three Xinjiang Basins Are Receiving Increasing Attention"]

[Text] Three large basins located in Xinjiang Uygur Autonomous Region are receiving increasing attention because of their rich energy resource reserves and broad development prospects.

These three basins are Junggar Basin in north Xinjiang, Tarim Basin in south Xinjiang, and Tu-Ha (Turpan-Hami) Basin in east Xinjiang. They cover a total area of 739,000 square kilometers, almost half Xinjiang's total area.

Forecasts by the relevant experts indicate that petroleum and natural gas resources in these three basins account for about one-fourth of China's total petroleum resources and one-third of our total natural gas resources.

After more than 10 years of large-scale and concentrated exploration by China's petroleum geology workers, Tarim Basin, covering an area of 560,000 square kilometers, has become a hopeful new area for China's petroleum industry. Seven oil deposits have now been discovered in Tarim Basin. Industrial oil flows have been discovered in the Lunnan, Yingmaili, and other structural zones in north Tarim. Of particular significance are the industrial oil and gas flows drilled from the 8,200 kilometer-square Tazhong [central Tarim] structure. Those concerned think it may become China's biggest oil field.

Junggar Basin was the site of China's first oil field, Karamay Oil Field. This oil field now produces over 6 million tons of petroleum, making it China's sixth largest oil field. Another seven oil deposits and one natural gas deposit were discovered in the eastern Junggar Basin in recent years. The two oil fields now being developed have completed a 1.4 million ton production capacity.

Turpan-Hami Basin covers just 40,000 square kilometers but industrial oil and gas flows were recently drilled from five exploratory wells in this basin, indicating that this basin will become one of China's new oil and gas producing regions.

The state is now expending substantial forces to explore and develop these three large basins. There are now several 10 drilling rigs and over 10,000 geological workers at work in Tarim Basin. In the next few years, the China Petroleum and Natural Gas Corporation will spend over 1 billion yuan renminbi on exploration in this region. Besides the several large oil refineries and petrochemical enterprises originally in Junggar Basin, a large ethylene project is now being planned.

Coal has also been discovered at several locations in Junggar and Turpan-Hami Basins. Xinjiang as a whole is projected to have one-third of China's total coal reserves, first place in China. Xinjiang now produces over 20 million tons of coal annually. Urumqi, Hami Sandaoling, and Aywar coal mines in the Tian Shan have now become Xinjiang's three big coal base areas. The state will also invest in building a big coal mine 20-plus kilometers west of Urumqi.

Hainan Oil Field Begins Operations

40100001A OW2109212390 Beijing XINHUA in English 1547 GMT 21 Sep 90

[Excerpts] Hainan, September 21 (XINHUA)—Hainan's HZ-21-1 oil field recently began operations. The field is operated by a group consisting of the Nanhai East Oil Corp. of CNOOC (China National Offshore Oil Corp.)

and oil companies of the United States and Italy. Its peak annual output will reach 1.15 million tons (about eight million barrels).

[Passage omitted]

CNOOC General Manager Zhong Yiming said that six other oil fields are being prospected in Hainan, and that the HZ-26-1 field would be operational very soon.

To date, only 98 test wells and 22 appraisal wells have been drilled in the 240,000 sq km shallow water areas—areas less than 500 meters in depth—including the area along the Zhujiang River estuary, areas to the southeast of Hainan Island and in the Yinggehai Basin.

[Passage omitted]

Siemens Named as Possible Partner in Jilin Nuclear Project

40100007A Beijing CHINA DAILY (Economics and Business) in English 28 Sep 90 p 2

[Article by staff reporter Xu Yuanchao: "Jilin Looks Abroad for Nuclear Project"]

[Text] China will seek international cooperation to build a 200-megawatt low temperature nuclear reactor in northeast China's Jilin Province.

The experimental project will be the first in China to substitute nuclear energy for coal. The project will require an investment of 160 million yuan ($34 million), half of which will be provided by the government and the remainder by the Jilin Chemical Industry Corporation, an official of the State Planning Commission said yesterday.

When the reactor is completed by 1995, it will be able to supply central heating and hot water to 60,000 households in the corporation's 3-million-square-metre living quarters.

The reactor will save 300,000 tons of coal per year and will be able to avoid the environmental pollution caused by burning coal, the official said.

He said "a possible partner" in building the reactor may be the West Germany company Siemens.

Siemens

"Siemens, which got involved in China's plan for the nuclear power industry, has expressed interest in the project," the official said.

Nuclear experts admit that control metres and instruments made by Siemens are better suited to the reactor than domestic ones.

Other equipment will be manufactured by Chinese factories through bidding after a feasibility study by the Institute of Nuclear Energy Technology of Qinghua University and a research institute of the China Nuclear Industry Corporation is completed.

Design of the reactor will be based on a 5-megawatt experimental reactor, which was approved a week ago.

The reactor will be built in a site about three kilometres away from the Jilin Chemical Industry Corporation. The site was once selected for a proposed nuclear power station.

This reactor is safe, clean, economical and ideal for big cities in north China and the northeast, the official said. It can operate 30 to 40 years.

Since the 5-megawatt experimental reactor built by the Qinghua University is operating successfully, he said, an increasing number of cities and enterprises have inquired about building such a reactor.

Water as a Fuel—Old Dream May Be Near Realization

906B0087A Zhengzhou HENAN RIBAO in Chinese 5 May 90 p 1

[Article by reporter Wu Zongze [0702 1350 3419]: "Cui Zhenxing [1508 2182 5281] Boldly Overcomes Problems in Studying New Energy Resources, Dream of Using Water as a Fuel Becoming a Reality, Distance Between China and Advanced World Levels Reduced 20 Years"]

[Text] A high-temperature flame at almost 3,000°C erupts from the barrel of a small electrolysis tank device when a bucket of common water is poured into it and it is connected to a power source. This generator which converts water into a hydrogen-oxygen gas fuel was successfully developed by accomplished welding equipment development expert, director of Zhengzhou Welding Equipment Institute, and senior engineer Cui Zhenxing and his assistant Su Bingqian [5685 0014 0051]. It passed on-site operations tests and data examination and approval by experts organized by science and technology commissions at the state, provincial, and city levels on 29 April 1990. They consider this a major breakthrough in China's research on new energy resources, and it reduced the distance between China and incisive world technical research levels in this field by 20 years.

Theories concerning the reduction of water, which is composed of hydrogen and oxygen, into a fuel were acknowledged by scientific circles quite some time ago. Still, reduction of water to make a sufficiently flammable gas for utilization in a small easy-to-use device is certainly a major breakthrough in the field of world high technology. It was successfully understood by a few developed nations in the world in the late 1980's only after many years of exploration. In a situation in which foreign countries refused to supply equipment and implemented technical blockades, Cui Zhenxing and Su Bingqian, who have made several important achievements in R&D on welding machinery and equipment, boldly devised ways and fought tenaciously to conduct over 10,000 experiments with assistance from China's famous welding expert Sun Zijian [1327 1311 1696] in eventually giving birth to the finalized design for this integrated mechanical, electrical, chemical, and gas 2 X R dual-gas fuel generator and formed the capacity to produce over 1,000 units a year.

The dual-gas fuel generator is a single device with multiple functions. It can do cutting, welding, and brazing of ferrous and nonferrous metals. In particular, it has solved problems in processing low-carbon steel that were not solved with similar equipment in foreign countries. It has a wide range of uses in national defense, aviation, shipbuilding, machine manufacturing, chemical industry, communications and transportation, food processing, jewelry processing, and other areas. The dual-gas generator consumes 5 kWh of electricity and uses 600 grams of water to produce 1,000 liters of flammable gas per hour. Its power consumption is just one-third and its production application costs one-tenth that of traditional applied acetylene fuel generators, and its price is one-fifteenth that of similar generators in international markets. A major scientific research achievement for Henan Province, this project has been included in State Science and Technology Commission "high efficiency and energy conserving demonstration projects."

Great Value Seen in Utilization of Geothermal Resources

906B0087B Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 11 Apr 90 p 4

[Article by Zheng Zhixin [6774 1102 1800]: "Great Value From Comprehensive Utilization of Geothermal Energy"]

[Text] Geothermal energy is a new energy resource with substantial development potential. China alone has over 3,000 medium and low-temperature geothermal sites. Because some people doubted the benefits of developing medium and low-temperature geothermal energy, it was never fully utilized. With dual support from scientific research departments and bank loans, Tuanbo Village in Jinghai County, Tianjin Municipality successfully established a comprehensive geothermal energy utilization base area that provides a new route for developing energy resources, which are in increasingly short supply.

In the early 1980's, exploration by geological and mining departments led to the discovery that Tuanbo Village was located in the middle of Wanglanzhuang geothermal field. It has a groundwater temperature of 78°C and reserves of 8.37 billion cubic meters, which are extremely excellent prospects for exploitation. Subsequently, the Tuanbo Integrated Agriculture, Industry, and Commerce Company assumed responsibility for the tasks involved in developing these thermal resources and enlisted the Tianjin Geothermal Research and Training Center at Tianjin University (abbreviated below as the Tianjin University Geothermal Center) to do planning, design, and experiments for utilizing Tuanbo Village's geothermal energy. Over the past 4 years, with substantial support by the China Bank of Industry and Commerce and through research on heating, engineering technology, comprehensive utilization in agriculture, corrosion prevention, antiscaling, environmental protection, and other topics, a geothermal well pumphouse has been established here and outfitted with water-resistant corrosion-resistant insulated buried pipelines to establish 16 geothermal fish overwintering ponds, 10 geothermal greenhouses, one edible fungi breeding ground, and 450 square meters of nestling incubators. Geothermal energy is also being utilized to heat a silk plant, cart shaft plant, clothing plant, repair and supply plant, and other structures, for hot water for technical uses, and for bathing by village residents. Geothermal energy is

also being used for early fry breeding and to establish a 10,000-mu integrated fish and reed project and two water lifting stations.

In 1989, Tuanbo Integrated Agriculture, Industry, and Commerce Company cooperated further with enterprises in Hong Kong, Japan, and other places to import advanced technologies and establish the Tianjian Integrated Company, Ltd. through joint Chinese and foreign investments for using geothermal water to develop breeding of soft-shelled turtles, bullfrogs, snails, and other special products that are supplied to Chinese and foreign markets and create a foreign exchange earning capability. By the end of 1989, they had gradually formed a preliminary economically diversified technical demonstration base area focused on comprehensive utilization of geothermal energy.

For the past 4 years, Tuanbo Integrated Agriculture, Industry, and Commerce Company's value of output and profits have grown every year. The value of output was 21.404 million yuan and gross profits were 6.733 million yuan. They conserved 10,000 tons of coal and supplied markets with 4.5 million jin of commodity fish, 300,000 jin of fry, 150,000 jin of pingmo mushrooms, 9.9 million jin of reeds, 275,000 jin of winter and spring vegetables, 2.5 million incubated nestlings, and 5.5 million meters of silk cloth as well as tableware, clothing, cart shafts, and many other industrial and sideline products. The 3 million yuan in loans from the Tianjin Bank of Industry and Commerce and Tianjin S&T Trust and Investment Company for developing comprehensive utilization of geothermal energy were paid back in their entirety on schedule. The input/output ratio rose from 1:1.85 in 1986 to 1:2.46 in 1989. All of the adobe houses that served as residences for the entire village in the past have been demolished and replaced with newly built courtyard-style brick and tile houses. Per capita yearly income has risen from 300-plus yuan prior to development and utilization of geothermal energy to the current figure of 1,200 yuan and there have been substantial improvements in people's living standards. In 1989, the village also spent 1 million yuan to build a four-story office building heated with geothermal energy. The Tianjin Municipal People's Government recently approved development and construction of Tuanbo region into a key scenic and tourism region for Tianjin Municipality and it will be opened up to Chinese and foreign tourists for its special geothermal utilization and reservoir scenery characteristics.

If all of China's 3,000-plus geothermal energy sites can achieve comprehensive development and utilization like Tuanbo Village, they could play a major role in China's economic construction.

Future Utilization of Alternative Energy Sources in Xinjiang Outlined

906B0085A Chongqing XIN NENGYUAN [NEW ENERGY SOURCES] in Chinese No 5, 5 May 90 pp 10-15

[Article by Zhang Hua [1428 5478] of the Xinjiang Institute of New Energy Sources]

[Text] Abstract: Based on the current status of rural energy sources in Xinjiang, predictions are made for future rural energy structure and demand. A proposal is put forth for the integrated utilization of rural energy sources and an investment budget and benefits analysis is also made.

The rural energy problem in the short term affects the agricultural development and the standard of living of the rural population (three-fourths of the total population) and in the long term affects the survival of future generations of the nation. Today there is a severe energy shortage in southern Xinjiang and cooking relies mainly on firewood, stalks, and animal manure. Vegetation coverage of the desert is rapidly decreasing and soil erosion and weathering are severe. Organic matter is not being returned to the fields and nutrients in the soil are on the decline. The benefits of village enterprises and by-products and mechanized agricultural production have not been achieved and the energy shortage is impeding agricultural production. If the energy problems are not solved, they would definitely affect the economic development goals of this region.

Along with the development of the national economy and the rise of the village enterprises and the third industry, the standard of living of the farming and ranging population has been continually improved. Rural construction and the comprehensive utilization of energy have attracted the attention of the government and farmers and herders. In this paper we present a proposal for the comprehensive utilization of alternative energy sources in Xinjiang with the hope that it would contribute to the solution of the energy problem and to the modernization of the rural area.

Guiding Principles of the Design Plan

1. Consider the residential energy consumption together with the energy needs in agriculture, industry and by-products.

2. Design energy utilization according to the local situation and improve the efficiency by making comprehensive and complementary usage of the energy sources.

3. Take into account the special situation in the region and the living habits of the ethnic population.

4. The plan should consider the rational use of energy and energy conservation, and take into account the

requirements of ventilation, heating, and fire prevention in dwellings.5. The plan should be economical and practical in order to be promoted in the Xinjiang region.

Comparison and Comprehension

The problem of rural energy is a broad problem that touches upon not only agricultural production and standard of living of the farming population but also the ecological balance and the development of the national economy. In considering the rural energy problem, one should take into account the multiple goals of food, feed, fertilizer, fuel, and the agricultural ecological cycle in order to establish a rational energy structure and supply system. Based on the current situation of commercial energy supply, the basic solution of the rural energy problem is to develop natural energy sources in the rural area and diversify energy sources. There are a variety of energy sources in the fields, including solar energy, biomass, wind energy, and hydropower.

1. Solar Energy

Xinjiang has an abundant supply of solar energy. The total number of hours of sunshine per year is between 2,300 and 3,300. The sunshine percentage is 60 to 80 percent and the total annual solar radiation is 130 to 160 Cal/cm^2, which is the second highest in China. Xinjiang is particularly blessed with solar energy.

2. Biomass

The fields, mountain forests, prairies, and fishing grounds are all immense reserves of biomass. In 1984 the total energy resource in Xinjiang's rural area was 12.905 million tons of standard coal (same units used below if not specified), out of which 10.56 million tons (82.8 percent of the total) were from biomass. The biomass energy sources in Xinjiang include 3.10 million tons of stalk (24 percent of the total), 6.01 million tons of manure (46.6 percent of the total), and 1.45 million tons of firewood (1.2 percent of total energy). Renewable materials make up a high fraction of Xinjiang's rural energy structure.

3. Wind Energy

Xinjiang has abundant wind energy in its nine wind energy districts. The total wind energy reserve in the region is about 189.10 million kilowatts. This could generate 819 billion kilowatt-hours of energy a year. This is equivalent to 34.398 million tons of standard coal and is 200 times the total electricity production in Xinjiang in 1985.

4. Hydropower

There is a total of 721 rivers in Xinjiang, with a total flow volume of 8.1029 million cubic meters. The theoretical hydropower reserve is 33.5545 million kilowatts for an annual electricity production of 293.94 billion kilowatt-hours. The hydropower reserve of Xinjiang is equal to 5 percent of the national hydropower reserve and ranks fourth in China, preceded by Tibet, Sichuan, and Yunnan.

In today's world, these energy sources are used in two different ways. One way is to use a single natural energy source or to use several natural energy sources at the same time. This method of energy usage is flexible and convenient but not stable. The other way is to convert several natural energy sources into electric energy and then form a small system. This method has been considered in some regions.

Because there exists a certain complementary relationship between solar, biomass, wind, and hydropower, this relationship provides the possibility of comprehensive energy usage. In the rural area energy is used for cooking, heating, irrigation, lighting and by-products production. In order to minimize the number of conversions, methane gas may be used for fuel, solar or wind powered water pumps may be used for irrigation, small hydro or solar cell may be used for lighting and electric power, and methane powered motor may be used for producing by-products. Stalk should be used as feed or returned to the field for soil enrichment. By forming a complete energy supply system based on a variety of sources, overall efficiency will be improved, cost will be reduced and the ecological environment will be improved.

Analysis of Future Rural Utilization of Energy

The future energy usage can be divided into three large categories: residential and home energy usage, energy consumption by public and welfare facilities, and production energy consumption in rural industry and by-product business.

In 1984 the rural energy consumption in Xinjiang, converted to standard coal, was 6.9235 million tons, which was 50 percent of Xinjiang's energy usage in 1984. The structure of Xinjiang's energy consumption is detailed in Table 1.

Table 1. Rural Energy Consumption in Xinjiang in 1984

Item		Quantity (10,000 tons)	Standard coal (10,000 tons)	Percent
Agricultural production			211.33	30.5
Direct	Coal	51.26	36.6	
	Oil	38.28	54.69	
	Electricity (kilowatt-hour)	4.432	18.66	

Table 1. Rural Energy Consumption in Xinjiang in 1984 (Continued)

Item		Quantity (10,000 tons)	Standard coal (10,000 tons)	Percent
Indirect	Chemical	42	100.79	
	Fertilizer	0.16	0.61	
	Steel stock		481	
Energy usage in rural life				69.5
Where,	Stalk	297.14	148.07	
	Firewood	185.15	105.72	
	Animal manure	157.86	90.13	
	Coal	183.86	131.28	
	Petroleum	0.70	1.00	
	Lighting	1.184	4.82	
Total			692.35	
Per capita average (kg/man yr)			696	

Based on the energy consumption structure of rural Xinjiang and the civilian energy usage in Japan, and taking into account the economic development of Xinjiang in 1990-2000, the three energy categories in Xinjiang may be given the following percentages:

1. Residential and home energy consumption: 50 percent

2. Public facility (schools, kindergartens, clubs, village government, etc.): 15 percent

3. Industry, agriculture, by-products and production consumption: 35 percent

Compared with the energy consumption in 1984, residential energy use has dropped. This was mainly caused by an increase of the energy consumption by public facilities, industry, agriculture, and by-products production and an increase in efficiency in the residential use of energy. As the rural economy develops and the standard of living improves, the energy consumption of the public facility and culture activity is suitably increased. Industrial and by-product production has also increased in the development of the rural economy and agriculture.

We now analyze the total energy consumption of a 100 family, 500 population village with 2,000 mu of farmland. (Statistical data showed that there are 4.67 persons per family and 4.76 mu per person in rural Xinjiang.)

The total energy consumption of the village is based on the residential energy consumption of a family of five, as shown in Table 2.

Table 2. Home Energy Consumption for a Family of Five in Rural Xinjiang in 1990-2000

Item	Usage	Energy consumption		Percent
		Per unit time	Annual total	
1	Heating	Heating coal for 5 mo., 1.2 ton/family yr	600×10^4 Cal (0.86 tons of standard coal)	33.9
2	Cooling	Refrigerators in 30% of households, 30 kWh per family per mo., 360 kWh per family per year	31×10^4 Cal (0.15 tons of standard coal)	1.75
3	Hot water	6 mo/yr, 3,000 Cal/day, 5.4×10^5 Cal/family yr	54×10^4 Cal (0.077 tons of standard coal)	3.05
4	Cooking	5 kg/day of coal (0.4 kg of LNG, 1 m^3 of methane), 1.825 ton/family yr	913×10^4 Cal (1.3 tons of standard coal)	51.6
5	Lighting	10 kWh/mo, 120 kWh/family per year	10.3×10^4 Cal (0.05 tons of standard coal)	0.6
6	Other	Space heater, remodel and repair, added transport, based on 10% of annual total consumption	161×10^4 Cal (0.23 tons of standard coal)	9.1
7	Total		1770×10^4 Cal (2.528 tons of standard coal)	100

Based on the energy consumption per family in Table 2, and the predicted percentages stated above, we arrive at the following results:

The household energy consumption in the village was $173,220 \times 10^4$ Cal, the public works energy consumption was $51,960 \times 10^4$ Cal, and energy spent on industry, by-product and agricultural production was $121,254 \times 10^4$ Cal. The total energy consumption of the village for a year is therefore $346,434 \times 10^4$ Cal. Taking the heat value of coal to be 5,000 Cal/kg, it would require 693 tons of coal to produce the total energy consumed by the village. Converted to standard coal, this would be 495 tons, equivalent to a consumption of 1 ton of standard

coal per person per year. Statistics show that the total commercial energy consumption in rural Xinjiang in 1984 was 2.47 million tons of standard coal and the per capita standard coal was only 0.25 ton. Therefore, it would be impossible for the region to solve the energy problem and satisfy the per capita commercial energy of 1 ton of standard coal or 1.4 tons of raw coal in the 1990-2000 period. But in the meantime the rural economic development and the improvement of the living standard for the farming and ranching population cannot do without this level of energy consumption.

Approaches for Solving Future Rural Energy Problems

To solve the problems in the rural economic development and the energy needs in the improvement of the standard of living, we must be self-reliant and solve 70 to 80 percent of the total energy consumption; the remaining 20 to 30 percent may be supplied by the state. We strive to reach 60 to 80 percent self-sufficiency by the year 2000. To this end, we propose the following measures and actions to solve the rural energy problem:

1. Based on the local weather, environment, and income level, promote the use of "three furnaces" (fuel economic furnaces, methane furnaces, and solar furnaces) in Xinjiang.

(1) Build a 5m x 5m x 6m methane pool with a volume of 150 m^3 and a daily production of 120-130 m^3 of methane gas. The ground part of the methane pool may be constructed into a 100 m^2 greenhouse for maintaining the pool temperature in cold weather and for planting vegetables and mushrooms. For a 10-month year, the pool may save 150 tons of coal, which is equivalent to 21.6 percent of the total energy consumption of the village or 82 percent of the energy used in cooking. The methane gas will be used mainly for residential cooking but may also be used for electricity generation in an emergency.

(2) Each household in the village will have a solar furnace that can be operated 200 days in a year. This will save 800-1,000 kilograms of coal, which is 80-100 tons in the whole village. This is equivalent to 12-14 percent of the total energy consumption in the village or 44-55 percent of the energy used for cooking.

2. The residential housing and public buildings in the village will all be designed into passive solar houses. If the supply rate of the solar houses during the heating period (i.e., the solar energy guarantee rate) is 70 percent, then 84 tons of coal may be saved in 1 year, which is 12 percent of the village's energy usage or 70 percent of the heating energy. The shortfall in heating energy will be made up with coal or firewood.

3. Each household will be equipped with a 1 m^2 family style solar hot water heater. It can be used 6 months out of the year and can supply the family with hot water for daily use and bathing. The cooking energy usage will be reduced when the hot water is used in making boiling water. The public buildings in the village may also be equipped with a number of public solar bathhouses to save 16 tons of coal (2.3 percent of the total energy usage).

4. A cooking and heating stove will be installed in each household. The stove will be burning coal or firewood to satisfy the 30 percent shortfall in heating and the 20-50 percent cooking needs. This will be about 13 percent of the total energy consumption.

5. In appropriate regions, a major effort should be directed at the development of forests for fuel to alleviate the shortage in coal.

6. In regions far away from the power grid, methane, wind power, and solar generators may be installed to satisfy the 4 percent of the village's energy that is used for electricity production.

Comprehensive Energy Utilization Plan and Environmental Balance Plan

The diagram below depicts the comprehensive utilization of energy and the environmental balance in rural area.

This plan has the following characteristics:

(1) The plan took into account the comprehensive and complementary use of different energy sources. The cooking energy relies mainly on methane and solar furnaces. When the methane output stops or when the solar furnaces cannot be used in the winter, dual-use furnaces and firewood may be used instead. Also, solar energy will provide enough hot water for cooking.

(2) The plan is mainly self-sufficient based on the local energy sources; the portion to be provided by the state is minimal. Therefore, if the state supply is not coming on time due to transportation or other problems, the production and home living in the village will not be affected.

(3) This plan solved the environmental pollution problem caused by the burning of fuel. Clean, nonpolluting energy sources (methane, solar, wind, and electric) account for more than 80 percent of the total energy consumption. The roots of pollution are eradicated.

(4) The plan took into account the balance of the environment. Manure and crop stalk are used as the raw material for producing methane and the residue of the methane pool can in turn be used as fertilizer for growing crops and vegetables, or for feeding fish. In this plan, the sanitary condition of the village can be maintained and the medium for the occurrence and spreading of communicable disease is eliminated.

Investment Budget of the Comprehensive Use of Energy Sources

The new plan for the comprehensive utilization of energy sources will require a total investment of 410,000 yuan, as shown in Table 3. The total construction budget of the village is 1.21 million yuan and the investment in energy is 27 percent of the total investment.

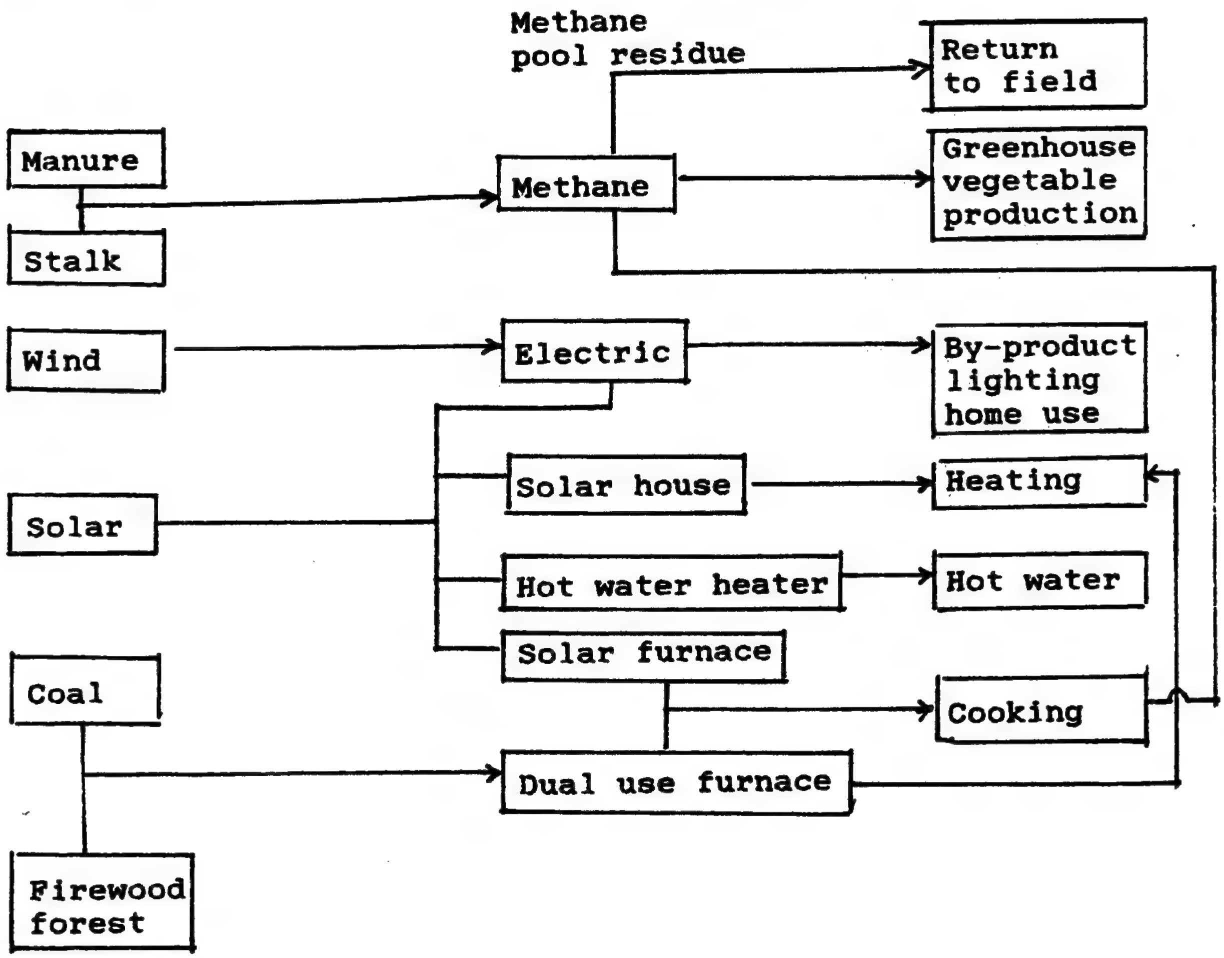

Table 3

Index	Energy	Target and technical requirement	Investment	Construction cost
1	Methane	1) 150 m^3 methane pool, producing 120-130 m^3 per day, supplying gas for 10 months per year, including greenhouse investment	1) 400 yuan/m^3, 60,000 yuan for 150 m^3	1) 70 m^3 per house, 150 yuan per m^2, 1.05 million yuan for 100 households
		2) 50 kW facility for generating electricity	2) 50,000 yuan	2) 400 yuan/m^2 for public buildings, 200 yuan/m^2 to build, at a total of 80,000 yuan
2	Solar house	Designed for dwellings with room temperature of 18°C +/- 4°C, assurance rate of 70 percent in solar heating invest at 10 percent of building constructing costs	110,000 yuan	3) Road construction taken to be 5 percent of total investment; 80,000 yuan for this
3	Solar hot water furnace	1) Each house equipped 1 m^2 lighted area, 100 kg hot water furnace	1) 150 yuan x 100 = 15,000	
		2) Collective heater 50 m^2	2) 300 yuan x 50 m^2 = 15,000	

Table 3 (Continued)

Index	Energy	Target and technical requirement	Investment	Construction cost
4	Electric power by wind, and solar	For wind, 3,000 yuan per kW, assume 5 kW (solar cells are expensive, total investment taken to be 150,000 yuan)	150,000 yuan	
5	Firewood	Grow new firewood forest, 100 yuan per mu, total 100 mu	10,000 yuan	
6	Total		410,000 yuan	121,000 yuan

Economic and Social Benefits Analysis

A preliminary analysis of the economic benefits is shown in Table 4. As can be seen, the recovery time (4 years) for firewood forest is the shortest. The recovery time for hot water heaters is 3 years; for solar houses it is 18 years; for methane pools (including greenhouses) it is 8 years; for generating electricity using methane gas the recovery time is 6 years, and for generating electricity with wind power it is 18 years. On a whole, the economic benefits are good. More importantly, the social benefits of the plan are prominent. First of all, the plan is good for the environment and can fundamentally solve the soil erosion problems of the rural area and return the villages to an ecologically balanced state. Second, the plan is good for the development of agriculture, industry, byproducts, farming, and ranching and is beneficial to rural economic development. Third, by developing the energy sources in a uniform manner, there is a great saving of the land needed. Finally, the plan will improve the intellectual and cultural development of the rural area and raise the standard of living of the residents.

Table 4

Index	Energy	Economic benefits analysis method	Economic income
1	Methane or solar	10 months to the year, saving of 4 yuan per household per month	4,000 yuan
2	Methane or wind	Annual electric output of 40,000 kWh, 0.2 yuan per kWh	8,000 yuan
3	Methane greenhouse	Growing mushrooms in greenhouse, producing 40 kg/m^2, net income 1.0 yuan/kg	4,000 yuan
4	Hot water heater	Household heater used 100 days per year, 4 persons taking bath per day. Public heaters assumed 2 bathers/m^2, each bath costs 0.2 yuan	10,000 yuan
5	Solar house	Saving 1.2 tons of coal per household per year, at a price of 50 yuan/ton	6,000 yuan
6	Public solar house	Saving of 10 tons per year	500 yuan
7	Firewood forest	Assuming an income of 25 percent of the investment	2,500 yuan
8	Annual total		62,000 yuan
Notes	(1) Solar furnaces can be operated 8 to 10 months per year.		Table 3 shows that total investment on energy is 460,000 yuan and income per year is 62,000 yuan. All the investments will be recovered in 7 years.
	(2) Generating electricity with diesel engine in rural area costs 0.5-0.8 yuan/kWh. We still use 0.2 yuan/kWh in calculation.		
	(3) Market price for fresh mushrooms is 3 yuan/kg, but a lower price is used in computing the income.		
	(4) Commercial bathhouses charge 0.4-0.6 yuan per person per bath, here the staff rate of 0.2 yuan/bath is used.		
	(5) Price of coal is 50 yuan/ton, with average shipping distance taken into account.		

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Henan Issues Provisional Energy Conservation Regulations

906B0083A Zhengzhou HENAN RIBAO in Chinese 12 May 90 p 2

[Article: "Executive Regulations of Henan Province Provisional Energy Conservation Administrative Rules"]

[Text] **No 17 Executive Order of Henan Provincial People's Government**

On 16 January 1990, Executive Regulations of Henan Province Provisional Energy Conservation Administrative Rules were passed at the third standing committee meeting of the provincial government. The regulations are announced as in force.

Provincial Governor Cheng Weigao [4453 4850 7559], 6 April 1990

Chapter One. General Rules

Item I: Based on provisions of Provisional Energy Conservation Administrative Rules (abbreviated as rules in later passages) of the State Council with reference to the province's real situation, these regulations were prescribed.

Item II: All offices, organizations, troops and enterprises within the province's boundary should comply with these regulations.

Item III: Energy sources in these regulations indicate coal, crude oil, natural gas, electric power, coke, steam, gasoline, diesel oil, fuel oil and faggot wood, among others.

Energy conservation in these regulations is defined as obtaining the maximum economic return with minimum energy consumption through technical progress, rational utilization, scientific management and economic structure rationalization.

Item IV: Various levels of propaganda and education departments (among others) should propagandize energy conservation guidelines and policies, popularize energy conservation science, technology and knowledge, as well as train energy conservation technical personnel by making adequate use of broadcasting, television, newspapers, magazines and lectures in addition to various levels (and categories) of schools.

Chapter Two. Energy Conservation Administrative System

Item V: Energy conservation leadership sections or committees are included in the people's governments of province, municipality (under prefecture), and county (under municipality); offices are set up in the planning economic commission, or the planning commission and economic commission, responsible for daily routine work.

The main missions of various levels of energy conservation leadership organizations are as follows: thorough enforcement of the state's related energy conservation guidelines, policies, laws, and regulations (including these regulations); study and specifying of energy conservation planning and measures of local administrative districts; approval and announcement of energy consumption quotas; organizing and directing energy conservation technology and development as well as technical innovations; coordination in solving the related problems of energy conservation; enforcement with unified administration of energy conservation.

Energy conservation administrative organs of province, municipality or prefecture levels may commission energy conservation technical monitoring agencies to monitor and examine production and household energy use within the respective administrative district.

Item VI: Various levels of energy conservation administrative agencies may appoint energy source monitoring personnel from professional technical personnel and administrative personnel engaging in energy conservation. After being examined and approved by the higher level energy conservation administrative agency, all qualified personnel are uniformly issued certificates identifying them of energy source monitoring personnel by the provincial energy conservation administrative agencies with authorization to monitoring enforcement within the assigned sphere. When carrying out official business, monitoring personnel should, first of all, show his (or her) authorization certificate.

Item VII: Various levels of enterprise administrative departments should have their major responsible personnel divided among themselves their duties in energy conservation. In addition, the appropriate administrative agency with well-defined authority has the responsibility of analyzing and specifying energy conservation technical measures of the industry, as well as drafting energy consumption quotas and limits; the major responsible personnel examine and evaluate energy consumption for the main products in providing guidance and supervision of the industry.

Item VIII: An enterprise should assign its main responsible person(s) to administer energy conservation. For enterprises with the annual consumption of more than 5,000 tons of standard coal, special personnel should be appointed to be responsible for energy conservation.

In an enterprise, the energy conservation administrative agency and administrative personnel should have the main responsibility in strictly enforcing the appropriate state guidelines, policies, laws, regulations and norms in prescribing and organizing the enforcement of energy conservation technical measures at the enterprise, in improving energy conservation scientific management, in lowering energy consumption per unit product, and in accomplishing energy conservation and the mission.

Chapter Three. Fundamental Work of Energy Conservation Management

Item IX: Various levels of statistical departments should put into effect a balanced energy source statistical system, and compile energy source overall balanced tables within the administrative district in order to conduct statistical supervision of energy consumption by enterprises within the administrative district.

Item X: Various levels of technical supervision departments should organize to enforce fundamental norms of state energy sources, energy source administrative norms, as well as energy consumption norms for products. In addition, energy conservation norms of the district, industry and enterprise should be specified according to the concrete situation with the same-level enterprise administrative departments. An enterprise should strictly enforce the various energy conservation norms.

Item XI: Various levels of enterprise administrative departments should join with energy source supply departments to periodically prescribe advanced and rational energy consumption quotas with examination. The energy consumption quotas of key products are specified and examined by the province. For products for which energy consumption quotas were not issued by state and province, specification and examination are conducted by municipality or prefecture.

Item XII: An enterprise should periodically analyze overall energy source utilization, predict energy conservation potential and energy consumption level, as well as compile energy conservation regulations and reform planning with organization and enforcement. An enterprise should analyze various kinds of energy consumption quotas down to the level of the shop, work shift, section and individual machine in order to set up an energy utilization post responsibility system. An enterprise should keep accurate raw data records and statistical accounts in energy consumption, as well as periodically deliver energy source statistical tables to statistical departments, energy conservation administrative agencies and enterprise administrative departments according to the energy source statistical system. An enterprise should be equipped with a complete line of energy source measurement tools, according to the state Enterprise Energy Source Measurement Tools To Be Supplied and General Administrative Rules; in addition, an enterprise should make overall measurement audits based on the requirements of energy audit and energy source management.

Chapter Four. Supply and Administration of Energy Source

Item XIII: Various levels of energy conservation administrative agencies should join with energy source supply departments and the enterprise administrative departments to organize the supplying of energy source and economize work based on a combination of supply and economizing, supplying with priority given to energy conservation units performing satisfactorily, guaranteeing key points, and simultaneously adhering to the general principle of organizing energy source supply and conservation. In conforming to the plan, energy sources should be supplied in set quantities or should be contracted with responsibility for the planned indicators based on the administrative method of awarding benefits from energy sources not used owing to conservation; no makeup is given to an energy source if there is overconsumption.

Item XIV: The coal production administrative departments should develop coal sieving and dressing operations as well as their processing industry in order to upgrade coal quality by supplying, on demand, users in meeting their needs.

Urban coal supply departments should supply power-use coal according to the demands of intermediate and small enterprises.

Item XV: Power supply departments should strictly enforce the planned power supply and the planned power consumption system. As specified by the State Council administrative departments, Power Supply and Consumption Rules in China should be adhered to rights and responsibilities of both sides in power supply and consumption.

In power supply and consumption, a scheme of different power charge rates is being enforced and gradually improved as to power load peaks and valleys, as well as during high and low water periods of hydropower. Thus, more power consumption is to be encouraged during high water periods, and in power load valleys; then the load factor can be raised.

Item XVI: Strictly control oil burning. New oil burning users should go through state's regular channels for examination and approval. When approved as enterprises allowed to burn oil instead of coal, these enterprises should subject their coal burning equipment to modifications within a specified period.

Oil consumption in diesel engine generator sets should be severely restricted. Generally, small diesel engine generator sets are to be limited only to areas lacking power supply, as well as hospitals, research units, posts and telecommunication facilities, broadcasting facilities, capital construction sites and other sites and units requiring these small power generating units. Oil is withheld from all other diesel engine generator sets.

Chapter Five. Energy Management for Industrial and Residential Use

Item XVII: On construction of industrial enterprises as well as rural and small town enterprises, full consideration should be given to the status of resources, equilibrium in supply and demand, rational product flow direction, and rational deployment of local energy sources.

Item XVIII: The following units are responsible for the overall balance of supply and demand in industrial

energy use: provincial planning and economic commissions, as well as planning commissions and economic commissions in municipalities under prefecture, and counties under municipality.

Strictly control the growth of small blast furnaces, small rotary furnaces, small electric furnaces, small coal (gas) engines, small steam power facilities, as well as small smelters for nonferrous metals, electrolysis units, and native method coking facilities. If reconstruction and development are needed, approval is required by province level industry administrative departments together with the provincial planning economic commission.

Item XIX: In areas of industrial concentration, energy conservation administrative agencies should join with the related units to gradually convert, according to plan, into the area-wide heat supply from the heat supply by inefficient and scattered boilers. When the heating load is steady year-round at a certain scale, the principle of thermal norms in electricity generation should be complied with in cogeneration of heat and electricity. At the same time, the following kinds of production should be organized in these plans: heat treatment, electroplating, casting, oxygen generation and other occupational production lines in order to raise the rates at which energy sources are utilized.

Item XX: The enterprise administrative departments should specify kiln and furnace grade with examination norms made in the given industry. Each year, examinations, evaluations and comparison of major kilns and furnaces are conducted (for upgrading) in those enterprises under jurisdiction. Out-of-grade kilns and furnaces are ordered to upgrade within a specified time period. With the combination of major, intermediate and minor repairs, the enterprise should apply the advanced energy conservation techniques of its industry for overall modifications, as well as for higher thermal efficiency of kilns and furnaces, in addition to longer furnace service life.

Item XXI: As to the operation and administration of the enterprise heat supply system as well as the utilization of residual heat, the appropriate rules of Technical Guidelines of Evaluating Rational Heat Utilization of Enterprises specified by the State Standards Bureau should be complied with.

For newly installed industrial boilers or remodeled boilers in the enterprise with expanded capacity, it is necessary to report to the local energy conservation administrative agencies together with the enterprise administrative departments, labor departments and energy supply departments for examination, inspection and approval.

Item XXII: An enterprise should actively recover dissipated residual heat and combustible gases. Under the premise of economic rationality, industrial enterprises near a coal mine should fully utilize low-caloric (raw) materials, such as coal gangue.

An enterprise should actively adopt new processes, new techniques, and new materials in order to discard equipment with high energy consumption within the period preset by the state.

Item XXIII: For household coal consumption in urban and rural areas, combustion efficiency should be steadily improved and the heat energy use rate should be raised, on the principle of energy conservation.

In rural areas, faggot forests should be actively planted; household ovens with low faggot consumption should be designed and built. The following new energy sources should be actively developed: small hydropower facilities, marsh gas, solar energy, wind energy and geothermal energy, among others.

In building design, requirements for energy conservation should receive attention. Under the premise of meeting design standards, thermal engineering performance of enclosure structures should be enhanced; low-energy-consumption items of equipment should be adopted; natural light is to be utilized to the greatest extent; and heating and air conditioning parameters are to be controlled according to standards.

Unified planning and centralized heating are necessary for newly built residential housing and public buildings. For existing scattered heat supply systems, adequate measures should be vigorously instituted in order to gradually discard inefficient boilers for the centralized heating.

Item XXIV: Electricity and gas consumed by urban and rural residents as well as government administrative and enterprise units should have electricity and gas meters installed. The administrative and management units should regularly calibrate and inspect these meters for due maintenance and repair in order to ensure accurate measurement and to insist on charging based on the metered quantities. The fixed monthly charge system and free use of gas and electricity should be abolished.

Chapter Six. Technical Innovation Toward Energy Conservation

Item XXV: Various levels of energy conservation administrative agencies should actively organize new technologies in energy conservation in order to develop and promote the timely highlighting of key promotion items and enforcement plans.

Item XXVI: Energy conservation technical innovation capital for an enterprise should be disbursed from the depreciation fund of the enterprise and its retained production fund. Enterprises with energy consumption higher than the average level in the industry should concentrate all technical reform capital that the enterprise can spare for technical innovations aimed at energy conservation.

Item XXVII: In spending the loan account of energy conservation under the state credit loan plan, it is

allowed to repay loans from the recently raised revenues before the enterprise pays its income tax.

For enterprises with very low economic return but with higher social benefits, their account of capital construction allocation of the fund should be changed to a loan account. After reporting and approval by the provincial economic planning commission, the provincial finance departments and construction bank, partial or entire (100 percent) exemption of principal or interest can be allowed, according to state regulations.

Item XXVIII: Newly built, remodeled, and expanded engineering projects should adopt energy conservation equipment and advanced techniques. It is necessary to have special topic discussions on the rational use of energy through feasibility studies and initial designs of engineering projects.

For major energy conservation projects, design departments should be commissioned to present technical and economic arguments or feasibility studies.

Item XXIX: The provincial science commission should list the study of energy conservation techniques in the science research plan. Various levels of energy conservation agencies should actively organize research and promotion of energy conservation application technology.

Item XXX: Energy conservation machinery equipment as well as test instruments and meters imported by the enterprise for technical innovations can have their import custom duties and product (value added) taxes reduced or exempted, according to the state appropriate rules of tax law and regulations.

Technology and equipment (licensed and) imported from abroad should have their technical specifications fully scrutinized, in addition to economic return and energy consumption level. There must be application in advance, and approval by the state planning commission to import coal burning equipment.

Item XXXI: As announced by the state concerning obsolete machinery and electrical products to be discarded, the manufacturing enterprise should stop production and sales within the specified period.

When used by an enterprise and qualifying under the state-announced rules for obsolete machinery and electrical equipment that exceed energy consumption standards, this machinery and equipment should be shut down or be remodeled within a specified period. Transfer of this machinery and equipment for other uses is forbidden.

Item XXXII: Various levels of energy conservation technical service centers should actively develop a market for energy conservation technologies, with licensing of technologies at cost. Business activities of consulting information services, technical training and energy source measurement-testing are to be developed for the enterprise.

Chapter Seven. Awards and Penalties

Item XXXIII: Various levels of people's governments are to bestow praise and award to units and individuals with outstanding achievements in energy conservation.

Encourage people and the masses to take part in energy conservation. Those making rational proposals in energy conservation are to be awarded by the units receiving the benefits through adopting the proposal; awards are bestowed as per the rules of the State Council's Award Regulations for Rational Proposals and Technical Improvements.

Item XXXIV: Upon violating these rules and regulations, units or individuals are to be dealt with according to the following rules in different situations:

(1) Units or individuals restoring and developing, without permission, small blast furnaces, small rotary furnaces, small electric furnaces, small coal (gas) engines, small thermal power facilities, small-scale nonferrous metal smelters, and small electrolysis units, as well as native method coking facilities, can have their energy source stopped on decision of the energy conservation administrative agencies; in addition, their business licenses can be revoked by the administrative and management departments of industries and commercial firms.

(2) Units or individuals newly adding or expanding boiler capacity without permission are penalized with 50 percent of the cost of the newly added boiler or boiler capacity expanded; no energy source will be provided for the newly added boiler or the expanded boiler capacity.

(3) For units and individuals continuing to manufacture, sell, use or transfer (for other uses) the machinery as well as electrical products and equipment as indicated in Item XXXI, bank loans to these units and individuals are to be halted; in addition, the energy conservation administrative agencies are to halt the supply of energy sources, and are to penalize these units and individuals at 10 to 30 percent of the product or equipment cost.

For those severely wasting energy sources, the energy conservation agencies should assist the related departments to investigate and ascertain the administrative responsibility of the enterprise's responsible persons and other persons with direct responsibility, in addition to the above-mentioned disposition.

After these units and individuals have been penalized as mentioned above, they are not free from the continued enforcement of related business activities as specified in the enforcement of the rules and regulations.

Item XXXV: Upon consuming over-quota energy sources, enterprises should be charged on higher energy rates. The standard and administrative method of charging for higher rates are determined jointly by the provincial energy conservation administrative agencies, the provincial commodity price bureau, and the provincial finance department. The excess fees paid out on

higher rates are not allowed to be included in cost and extra-business expenditures. Income from higher rates should be jointly controlled by the energy conservation administrative agency for use in energy conservation measures.

For enterprises paying extra-charges at higher energy rates, they are not exempted from the responsibility of paying out penalties because they violated the rules in these regulations.

Chapter Eight. Appendix

Item XXXVI: In enforcing these regulations, concrete problems are to be interpreted by the provincial economic planning commission.

Item XXXVII: These regulations are in force on the day of announcement. If the past rules of Henan Province are in contradiction of these regulations, these regulations are to be preferred in enforcement.

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